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THE THELEPHORACEAE OF NORTH AMERICA. XIII[1]

CLADODERRIS, HYPOLYSSUS, CYMATELLA, SKEPPERIA, CYTIDIA, SOLENIA, MATRUCHOTIA, MICROSTROMA, PROTOCORONOSPORA, AND ASTEROSTROMA

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CLADODERRIS

Cladoderris Persoon in Gaudichaud, Voy. Urania Bot. 176. *pl. 1, f. 4.* 1826; Berkeley, Hooker's London Jour. Bot. 1: 152. 1842; Léveillé, Ann. Sci. Nat. Bot. III. 2: 213. 1844; Fries, Fungi Natal. 20, in K. Sv. Vet. Akad. Handl. 1848; Sacc. Syll. Fung. 6: 547. 1888; Engl. & Prantl, Nat. Pflanzenfam. (1:1**): 126. 1898; Lloyd, Myc. Writ. 4: Syn. *Cladoderris* 2. 1913.—*Cymatoderma* Junghuhn, Fl. Crypt. Javae. 1838. Translation of description of the new genera and species by Montagne, Ann. Sci. Nat. Bot. II. 16: 320. 1841, *Cymatoderma* being designated as a synonym of *Cladoderris*.—*Actinostroma* Klotzsch, Nova Acta Acad. Leop.-Carol. 19: 236. 1843.—*Beccariella* Cesati, Atti Accad. Sci. Napoli 8[3]: 9. 1879.

Fructification coriaceous, pileate, stipitate or sessile; hymenium inferior, with radiating or branched folds, ribs, or veins, verrucose also in some species; basidia simple; spores white, even.

The type species is *Cladoderris dendritica*.

Issued July 25, 1924.

The species of *Cladoderris* have the same internal structure as those of *Stereum*, and the genus is distinguished from the latter merely by the conspicuously ribbed configuration of the hymenial surface. The genus is tropical in its geographical distribution, although one species has been described from England and another from Florida; the fructifications grow on rotten wood. The earlier gatherings, consisting of only one or two fructifications at a time taken by explorers, sometimes had the stem central in the specimens saved, at other times lateral, and at others, sessile. Each such gathering was made the basis for a new species and the species were arranged in the genus in central-stemmed, lateral-stemmed, or sessile sections. Field observations and more ample collections by mycologists have reduced many such species to synonyms and show that the above sections are of little value; for in *Cladoderris*, as in the other *Thelephoraceae* growing on logs, the inclination of the substratum at the point of attachment and the position of the substratum as to whether over or under the fructification are important in determining the habit and form of the fructification, as already pointed out for *Stereum* and *Hymenochaete* (Mo. Bot. Gard. Ann. 5: 302. 1918).

Key to the Species

Hymenium not at all or but slightly verrucose.................*1. C. dendritica*
Hymenium abundantly verrucose.............................*2. C. floridana*

1. **Cladoderris dendritica** Persoon in Gaudichaud, Voy. Urania Bot. 176. *pl. 1, f. 4*. 1826 (under *Cladoderris* of *Thelephora*); Léveillé, Ann. Sci. Nat. Bot. III. 2: 213. 1844; Fries, Fungi Natal. 22, in K. Sv. Vet. Akad. Handl. 1848; Berk. & Curtis, Linn. Soc. Bot. Jour. 10: 328. 1868; Sacc. Syll. Fung. 6: 549. 1888; Lloyd, Myc. Writ. 4: Syn. *Cladoderris* 3. *text f. 520–523*. 1913. Plate 1, fig. 1.

Actinostroma crassum Klotzsch, Nova Acta Acad. Leop.-Carol. 19: 237. 1843.—*Cladoderris crassa* (Klotzsch) Fries, Fungi Natal. 22, in K. Sv. Vet. Akad. Handl. 1848; Sacc. Syll. Fung. 6: 549. 1888.—*C. Candolleana* Léveillé, Ann. Sci. Nat. Bot. III. 5: 153. 1846; Sacc. Syll. Fung. 6: 549. 1888; Lloyd, Myc. Writ. 4: Syn. *Cladoderris* 10. 1913.

Pileus coriaceous, usually flabelliform, drying pinkish buff, sometimes stained with adhering algae, stipitate or sessile, the upper surface spongy by the heavy coat of tomentum, the margin entire or nearly so; hymenium glabrous, marked with radiating, narrow, branched ribs, usually free from or with few warts; pileus in structure consisting of an intermediate layer, up to 150 μ thick, composed of densely longitudinally arranged hyaline hyphae about 3 μ in diameter, of a very much broader layer forming the tomentum of the upper surface of the pileus, and of a hymenial layer containing numerous, flexuous, fusoid gloeocystidia up to 60 × 8–12 μ; basidia simple, with 4 sterigmata; spores hyaline, even, 3–4 × 3 μ; no cystidia found; stem spongy-tomentose but often absent.

Pileus about 2–8 cm. in diameter.

On rotten wood. Mexico, West Indies, South America, Philippine Islands, Australia, and the East Indies. The usual species.

Cladoderris infundibuliformis of the Philippines and the East Indies differs from *C. dendritica* in having the upper side much less tomentose, hazel or kaiser-brown in color, radially ridged and with the ridges radially squamulose, and the hymenium containing some incrusted cystidia.

Specimens examined:

Mexico: Orizaba, *W. A. & E. L. Murrill, 775* (in N. Y. Bot. Gard. Herb., 775, and Mo. Bot. Gard. Herb., 54611).

Cuba: *C. Wright, 279* (in Curtis Herb.); Alto Cedro, *Earle & Murrill, 443*, comm. by N. Y. Bot. Gard. Herb.; Baracoa, *L. M. Underwood & F. S. Earle, 1217*, comm. by N. Y. Bot. Gard. Herb., *1139* (in N. Y. Bot. Gard. Herb.); Fecha, Habana, *Cooke & Horne*, comm. by Estacion Central Agronomica, 137; Oriente, *J. A. Shafer, 3748* (in Mo. Bot. Gard. Herb., 62171, and N. Y. Bot. Gard. Herb.); Pinar del Rio Province, *Earle & Murrill, 225*, comm. by N. Y. Bot. Gard. Herb.

Porto Rico: on dead cane, Rio Piedras, *J. R. Johnston & J. A. Stevenson, 1110* (in Mo. Bot. Gard. Herb., 55091).

Jamaica: ————, *331* (in N. Y. Bot. Gard. Herb., and Mo. Bot. Gard. Herb., 62172); Castleton Gardens, *W. Harris, 128*, comm. by N. Y. Bot. Gard. Herb. under the herbarium name *Stereum Harrisii* Mass.; Moore Town, *W. A. & E. L. Murrill, 136*, comm. by N. Y. Bot. Gard. Herb.

Colombia, S. Am.: Cauca River, *W. D. Denton*, comm. by W. G. Farlow.

Philippine Islands: Todaya, Mindanao, *A. D. E. Elmer*, *10747* (in Mo. Bot. Gard. Herb., 705748).

2. **C. floridana** Lloyd, Myc. Writ. 4. Letter 47: 15. 1913; Myc. Writ. 4. Myc. Notes 39: 535. *text f. 734.* 1915.

Plate 1, fig. 2.

Type: in Lloyd Herb. and in Mo. Bot. Gard. Herb.

Pileus coriaceous, cup-shaped, flabelliform or orbicular, drying tawny olive, spongy tomentose but with the tomentum thinning out towards the margin and the surface there zonate, short-stipitate or sessile, the margin thin, entire; hymenium wood-brown, paler towards the margin, densely, minutely warted, with very numerous, short, radially elongated ridges not continuous in a branched system; pileus in structure consisting of an intermediate layer, about 800 μ broad, composed of interwoven, longitudinally arranged, hyaline hyphae $2\frac{1}{2}$–$4\frac{1}{2}$ μ in diameter, of a broad layer of the tomentum of the upper surface of the pileus, and of a hymenial layer containing numerous flexuous gloeocystidia up to $60 \times 4\frac{1}{2}$–6 μ; spores hyaline, even, 3×2 μ; hymenial warts up to 80 μ high, 100–200 μ in diameter at the base, composed of a mass of erect, granule-incrusted hyphae; no cystidia found.

Pileus up to 5 cm. in diameter.

On frondose wood. Florida.

The hymenial warts are conspicuous in sections, even though not appreciably elevated above the hymenial surface, by contents of localized masses of granule-incrusted hyphae. This incrusting matter is of different nature from that usually present in the walls of hyphae, because it dissolves completely when the sections are treated with dilute potassium hydrate solution; lactic acid does not destroy the incrusting matter.

Specimens examined:

Florida: Bayard, type, comm. by C. G. Lloyd (in Mo. Bot. Gard. Herb., 56609).

HYPOLYSSUS

Hypolyssus Persoon, Myc. Eur. 2: 6. 1825, emend. Berkeley, Hooker's London Jour. Bot. 1: 139. *pl. 6, f. 1.* 1842; Sacc. Syll.

Fung. 6: 521. 1888; Engl. & Prantl, Nat. Pflanzenfam. (1:1**): 127. 1898.

Fructification urn-shaped or top-shaped, hard, corky; hymenium even, lateral.

In adopting the name *Hypolyssus* and defining it anew, Berkeley stated, *loc. cit.*, "As Persoon's genus *Hypolyssus* is altogether effete, and its characters are very like those of the plant before us, I have thought it advisable to restore it."

This genus differs from *Craterellus* by not having the fructifications at all fleshy and by their becoming hard when dry.

1. **Hypolyssus Montagnei** Berkeley, Hooker's London Jour. Bot. 1: 139. *pl. 6, f. 1.* 1842; Sacc. Syll. Fung. 6: 521. 1888; Engl. & Prantl, Nat. Pflanzenfam. (1:1**): 127. *text f. 70 E.* 1898. Plate 1, fig. 4.

An *Hypolyssus foetidus* Massee, Jour. Bot. 30: 197. *pl. 325, f. 3–5.* 1892; Sacc. Syll. Fung. 11: 115. 1895?

Type: in Kew Herb. probably.

Fructifications gregarious, dirty white, 1–2 cm. high, hard when dry, solid, turbinate or urn-shaped, the apex sterile, convex at first, at length slightly depressed; stem slender, central, curved, shorter than the pileus when mature; hymenium covering the outside of the fructification with the exception of the apex, even or nearly so; spores hyaline, even, 3–4 μ in diameter, none seen attached to basidia.

Fructifications 1–2 cm. high, 2–7 mm. in diameter.

On rotten wood. Mexico, Central America, Guadeloupe, and South America to Bolivia. February in Mexico, July in Bolivia.

The fructifications are hard when dry but soften when moistened so that they may be readily sectioned; *Craterellus taxophilus* is of somewhat similar form but more fleshy consistency. In all the specimens cited below the hymenium is too deteriorated to show the basidia in my preparations. *H. foetidus* occurs on the island of St. Vincent in the region of *H. Montagnei* and was distinguished from the latter by Massee by fetid odor and rugulose hymenium, but there is no observation on record yet as to absence of odor for *H. Montagnei*. Mycological explorers rarely note such data.

Specimens examined:

Mexico: near Sanborn, Oaxaca, *C. R. Orcutt, 3336* (in N. Y. Bot. Gard. Herb. and Mo. Bot. Gard. Herb., 37345).

Honduras: *P. Wilson, 237,* comm. by N. Y. Bot. Gard. Herb.

Guiana: *Spruce, 70* (in Curtis Herb.).

Bolivia: Mapiri, *A. M. Bang,* distributed by Columbia College Herb., 1479 (in Burt Herb., and Mo. Bot. Gard. Herb., 5002).

CYMATELLA

Cymatella Patouillard, Soc. Myc. Fr. Bul. **15**: 193. *pl. 9, f. 4–6.* 1899; Sacc. Syll. Fung. **16**: 49. 1902.

Marasmioid fungi, minute, stipitate, reviving with moisture; pileus lacking a pellicle; hymenium inferior, lacking lamellae, even or slightly wavy; spores hyaline.

Cymatella is a genus of a few species of tropical fungi, segregated from *Craterellus,* with which the specimens agree in the even hymenium and consistency, but related to *Marasmius* in structure of the pileus and the reviving of the specimens with moisture. The specimens are not notably marasmioid in the recent gathering which I have seen and the genus seems unnecessary.

1. **Cymatella minima** Patouillard, Soc. Myc. Fr. Bul. **15**: 193. *pl. 9, f. 6.* 1899; Sacc. Syll. Fung. **16**: 49. 1902.

Plate 1, fig. 6.

Pileus plano-convex, reniform, glabrous, pale russet (roux), 3–4 mm. broad, thin, very slightly fleshy, without a pellicle, the margin entire, straight, indented at the base; stem filiform, stuffed, 3 mm. long, glabrous, black, marasmioid, a little larger towards the base, attached to the pileus eccentrically near the indentation; trama composed of loosely arranged, septate, pallid-reddish hyphae 3–5 μ in diameter; hymenium inferior, dark red, even or with few radial, shallow undulations; basidia clavate, 20–23 × 5–6 μ, with 4 sterigmata; no cystidia; spores hyaline, even, ovoid, 3–4 μ long.

On decaying bark. Guadeloupe.

I have seen no specimens of *C. minima.* The figure, after Patouillard, somewhat resembles *Craterellus Humphreyi,* a much larger species, white in color and fleshy.

2. **C. pulverulenta** (Berk. & Curtis) Patouillard, Soc. Myc. Fr. Bul. 15: 194. *pl. 9, f. 4.* 1899; Sacc. Syll. Fung. 16: 50. 1902.

Plate 1, fig. 5.

Craterellus pulverulentus Berkeley & Curtis, Linn. Soc. Bot. Jour. 10: 328. 1868; Sacc. Syll. Fung. 6: 520. 1888.

Type: in Kew Herb. and Curtis Herb.

Fructification pallid ferruginous; pileus orbicular, pulverulent, the margin inflexed; stem thickened towards the base, black; hymenium sparingly venose, colored like the pileus.

Pileus 2 mm. broad; stem 2½ mm. long.

On bark of sticks. Cuba and Porto Rico. May and July.

A collection of a dozen or so fructifications from Porto Rico by Professor Stevens, taken in connection with specimens of the type collection in Curtis Herb., shows that while the original description of *C. pulverulenta* by Berkeley & Curtis, literally translated above, is correct as far as it goes it does not give details enough for critical comparison with *C. minima.* The specimens of *C. pulverulenta* are plano-convex rather than campanulate as stated by Patouillard, and the margin only slightly inflexed, entire but slightly notched behind near point of attachment of the stem which is sometimes nearly central but usually distinctly eccentric. The spores are hyaline, even, $3\frac{1}{2} \times 2$ μ in the type, $3\text{–}6 \times 2\text{–}2\frac{1}{2}$ μ in more copious occurrence in the Porto Rican gathering, and the hyphae slightly colored, 3–4 μ in diameter. The dry specimens in Curtis Herbarium now have the upper surface of the pileus Natal brown of Ridgway and the hymenium and the stem bone-brown.

Specimens examined:

Cuba: *C. Wright, 564,* type (in Curtis Herb.).

Porto Rico: Monte Alegullo, *F. L. Stevens, 1358* (in Mo. Bot. Gard. Herb., 55402, and Stevens Herb.).

3. **C. marasmioides** (Berk. & Curtis) Patouillard, Soc. Myc. Fr. Bul. 15: 194. *pl. 9, f. 5.* 1899; Sacc. Syll. Fung. 16: 50. 1902.

Craterellus marasmioides Berkeley & Curtis, Linn. Soc. Bot. Jour. 10: 328. 1868; Sacc. Syll. Fung. 6: 520. 1888.

Type: in Curtis Herb. and Kew Herb. probably.

Pileus eccentric, rugose, glabrous, rufous, the margin inflexed; stem springing from creeping rhizomorphs, thickened below, black; hymenial folds thick, venose; basidia simple; spores hyaline, even, globose, 4 μ in diameter—only one found and this not attached to a basidium; no cystidia.

Pileus 1½–2 mm. in diameter; stem 1–3 mm. long, about 140 μ in diameter.

On dead ferns. Cuba.

The fructifications are solitary or in small clusters of up to 5, branching from a common point on the bark and bone-brown throughout; stem central or eccentric in attachment to the pileus. The note on the label as to substratum is "on stumps."

Specimens examined:

Cuba: *C. Wright, 32*, type (in Curtis Herb.).

SKEPPERIA

Skepperia Berkeley, Linn. Soc. Bot. Trans. **22**: 130. *pl. 25, f. A.* 1857; Sacc. Syll. Fung. **6**: 603. 1888; Engl. & Prantl, Nat. Pflanzenfam. (1:1**): 127. *text f. 70. A–D.* 1898.

Stem short, lateral, abruptly passing over and confluent for some distance with the upper side of the pileus; pileus clavate, convolute on each side so as to form a longitudinal groove, fibrous within.

Skepperia convoluta is the type species.

Skepperia is a genus of tropical fungi of which three species have been described; two of these occur in South America and one in the West Indies.

1. **Skepperia spathularia** (Berk. & Curtis) Patouillard, Soc. Myc. Fr. Bul. **15**: 194. *pl. 9, f. 3.* 1899; Sacc. Syll. Fung. **16**: 189. 1902. Plate 1, fig. 3.

Craterellus spathularius Berkeley & Curtis, Linn. Soc. Bot. Jour. **10**: 328. 1868; Sacc. Syll. Fung. **6**: 603. 1888.

Type: in Curtis Herb. and Kew Herb. probably.

Fructifications minute, stipitate, everywhere pinkish buff in dried condition; pileus oblique, spathulate; stem springing from an orbicular base, becoming glabrous; pileus in structure 40–80 μ thick, composed of a layer of longitudinally arranged hyphae

and the hymenial layer; hymenium inferior, nearly even; no cystidia; basidia simple; spores hyaline, even, 5–7½ × 3–4 μ.

Dried fructifications about 2½ mm. long; pileus 1–1½ mm. long, 1 mm. broad; stem 1 mm. long, 120 μ in diameter.

On dead wood in Cuba and on *Nostoc* coating rocks in Trinidad.

Specimens examined:

Cuba: *C. Wright*, *3*, type (in Curtis Herb.).

Trinidad: Maravel Beach, near Port of Spain, *R. Thaxter* (in Farlow Herb.).

CYTIDIA

Cytidia Quelet, Fl. Myc. Fr.—. 1888; Patouillard, Essai Tax. . . . ; Bourdot & Galzin, Soc. Myc. Fr. Bul. 26: 222. 1910; Rea, Brit. Basid. 697. 1922.—*Lomatia* Karsten, Finska Vet.-Soc. Bidrag Natur och Folk 48: 403. 1889.—*Auriculariopsis* R. Maire, Rech. Cyt. Tax. 102. 1902, and Soc. Myc. Fr. Bul. 18: Suppl. 102. 1902; Sacc. Syll. Fung. 21: 423. 1912.

Fructifications coriaceous-gelatinous, cup-shaped, sessile, scattered or crowded, often confluent; hymenium even at first, becoming more or less wrinkled or veined; basidia simple; spores white.

Cytidia is a genus whose few species have usually been included in *Corticium* but differ from this genus in being resupinate by the middle only, with margins free as in some species of *Stereum*. The configuration of the hymenial surface is decidedly merulioid in our single indigenous species.

Key to the Species

White or nearly so, pubescent or tomentose .... *1. C. flocculenta*
White villose; hymenium blood-red .... *2. C. salicina*
Deep olive-buff to drab; hymenium becoming coarsely merulioid ... *3. C. tremellosa*

1. **Cytidia flocculenta** (Fr.) v. Höhn. & Litsch. K. Akad. Wiss. Wien Sitzungsber. 116: 758. 1907; Wiesner Festschr. Wien 61. 1908; Bourdot & Galzin, Soc. Myc. Fr. Bul. 26: 222. 1910; Rea, Brit. Basid. 697. 1922. Plate 1, fig. 7.

Thelephora flocculenta Fries, Elench. Fung. 1: 184. 1828.—*Corticium flocculentum* Fries, Epicr. 559. 1838; Hym. Eur. 647. 1874; Sacc. Syll. Fung. 6: 605. 1888.—*Cyphella ampla* Léveillé, Ann. Sci. Nat. Bot. III. 9: 126. 1848; Fries, Hym. Eur. 662.

1874; Sacc. Syll. Fung. 6: 667. 1888; Patouillard, Tab. Anal. Fung. 1: 113. *f. 254.* 1884.—*Auriculariopsis ampla* (Lév.) R. Maire, Soc. Myc. Fr. Bul. 18: Suppl. 102. *pl. 3, f. 22.* 1902; Sacc. Syll. Fung. 21: 423. 1912.—*Stereum pubescens* Burt, Mo. Bot. Gard. Ann. 7: 178. *pl. 5. f. 50.* 1920.

Fructifications membranaceous, cup-shaped, sessile, white-tomentose, the margin entire, free all around; hymenium veined, fawn-color or bright brown; spores white, even, 6–10 × 3–4 μ.

Fructifications 3–10 mm. in diameter, reflexed 1–3 mm.

On *Salix*. Montana and Wyoming. April and May. Rare.

In Europe, this fungus is more frequent on *Populus*. I described the Montana gathering as *Stereum pubescens* with some misgivings. A more recent collection from Wyoming has finally enabled me to refer this species to *Cytidia flocculenta*, a reference which I have confirmed by specimens kindly communicated to me by Bourdot. Since *C. flocculenta* occurs in the United States on *Salix*, gatherings in the past may have been referred to the common *Cytidia* (*Corticium*) *salicina*, from which it differs in smaller, more heavily tomentose pilei and much shorter spores.

Specimens examined:

France: Allier, *H. Bourdot, 4726*, and two unnumbered specimens; Aveyron, *A. Galzin, 13021*, comm. by H. Bourdot, 22632.

Montana: Sheridan, *Mrs. L. A. Fitch*, in Ellis Collection, 7014, type of *Stereum pubescens* (in N. Y. Bot. Gard. Herb., and Mo. Bot. Gard. Herb., 56784).

Wyoming: Boulder, *F. S. Wolpert*, comm. by J. R. Weir, 9742 (in Mo. Bot. Gard. Herb., 56222).

2. **C. salicina** (Fries) Burt, n. comb.

Thelephora salicina Fries, Syst. Myc. 1: 442. 1821.—*Corticium salicinum* Fries, Epicr. 558. 1838; Hym. Eur. 647. 1874; Sacc. Syll. Fung. 6: 605. 1888; Massee, Linn. Soc. Bot. Jour. 27: 118. *pl. 6, f. 1.* 1890.—*Lomatia salicina* (Fr.) Karsten, Finska Vet.-Soc. Bidrag Natur och Folk 48: 404. 1889; Icones Hym. Fenniae, 6. *f. 10.* 1885.—An *Cytidia rutilans* (Pers.) Quelet in Rea, Brit. Basid. 698. 1922? Plate 1, fig. 8.

Type: authentic specimen from Fries in Kew Herb.

Fructifications coriaceous, soft, drying horn-like, rigid, pezizoid when young, becoming expanded, more or less confluent, affixed by the center, the margin free all around and upturned, minutely white-villose; hymenium blood-red, even at first, drying somewhat wrinkled; in structure 400–800 μ thick, composed of parallel, longitudinally arranged and ascending hyphae with narrow lumen and walls gelatinously modified; basidia simple, with 2 or 4 sterigmata; spores hyaline, even, cylindric, curved, 12–15 × 3½–5 μ in American specimens, 16–18 × 6–8 μ in European specimens as recorded by Karsten also.

Fructifications 1–2 mm. in diameter at first, at length up to 6–12 mm. long by confluence.

On dead limbs of *Salix*. Northern Europe and Canada and northern United States. May to December. Common.

Rea gives *Corticium salicinum* as a synonym of *Cytidia rutilans* (Pers.) Quel., with spores globose, 8 μ in diameter. I do not find a species *rutilans* in the index of Persoon's 'Synopsis Fungorum' for any thelephoraceous genus and have not access to Quelet's 'Fl. Myc. France.' The globose spores point to a different species from *Corticium salicinum* Fries, with an authentic specimen of which, in Kew Herbarium, I compared one of my gatherings. The description of *Thelephora cruenta* Persoon, Syn. Fung., is too vague to take priority for the specific name over *salicinum* of Fries.

Specimens examined:

Exsiccati: Bartholomew, Fungi Col., 4218; Ellis, N. Am. Fungi, 609; Ell. & Ev., Fungi Col., 1212; Shear, N. Y. Fungi, 54; de Thümen, Myc. Univ., 114.

Sweden: *E. Fries* (in Kew Herb.).

Finland: Mustiala, *P. A. Karsten*, in de Thümen, Myc. Univ., 114.

Austria: Gastein Salisb., *Niessl* (in Mo. Bot. Gard. Herb., 43459); Innsbruck, *V. Litschauer*.

Canada: *J. Macoun*.

Ontario: Byron, *J. Dearness*, in Bartholomew, Fungi Col., 4218; Ottawa, *J. M. Macoun, 15*, comm. by N. Y. State Mus. Herb. (in Mo. Bot. Gard. Herb., 56082); Toronto, *J. H. Faull*, Univ. Toronto Herb., 315 (in Mo. Bot. Gard. Herb., 44882).

Maine: Cumberland, *J. Blake*, comm. by P. L. Ricker; Piscataquis County, *W. A. Murrill, 2089* (in N. Y. Bot. Gard. Herb., and Mo. Bot. Gard. Herb., 61421).

New Hampshire: Shelburne, *W. G. Farlow* (in Mo. Bot. Gard. Herb., 4777, 4836).

Vermont: Middlebury, *E. A. Burt*, three collections and in Ell. & Ev., Fungi Col., 1212; Shelburne, *C. G. Pringle, 1044* (in N. Y. State Mus. Herb., and Mo. Bot. Gard. Herb., 55908).

Massachusetts: Cambridge, *W. G. Farlow* (in Mo. Bot. Gard. Herb., 4386).

Connecticut: Litchfield, *Miss V. S. White* (in N. Y. Bot. Gard. Herb., and Mo. Bot. Gard. Herb., 61360).

New York: Albany, C. H. Peck, in Ellis, N. Am. Fungi, 609, *H. D. House* (in N. Y. State Mus. Herb., and Mo. Bot. Gard. Herb., 59692); Alcove, *C. L. Shear*, in Shear, N. Y. Fungi, 54; East Galway, *E. A. Burt;* Ithaca, *L. B. Walker, 3* (in Mo. Bot. Gard. Herb., 6693); Middle Grove, *E. A. Burt;* Van Etten, *W. C. Barbour, 1299* (in N. Y. Bot. Gard. Herb., and Mo. Bot. Gard. Herb., 61666).

Pennsylvania: Trexlertown, *W. Herbst*, comm. by C. G. Lloyd, 0053.

Michigan: Ann Arbor, *E. B. Mains*, comm. by A. H. W. Povah, 888 (in Mo. Bot. Gard. Herb., 58173); East Lansing, *G. H. Hicks* (in Mo. Bot. Gard. Herb., 4850); Marquette County, *W. Trelease* (in Mo. Bot. Gard. Herb., 60659).

Wisconsin: Palmyra, comm. by Univ. Wis. Herb., 58.

Colorado: Placer, *C. L. Shear, 1022;* Canyon City, *T. S. Brandegee* (in N. Y. Bot. Gard. Herb., and Mo. Bot. Gard. Herb., 61427).

Manitoba: Shoal Lake, *I. L. Conners*, comm. by G. R. Bisby (in Mo. Bot. Gard. Herb., 58973).

Idaho: Priest River, *J. R. Weir, 95, 357* (in Mo. Bot. Gard. Herb., 9534 and 17037 respectively).

Washington: Falcon Valley, *W. N. Suksdorf, 2.*

3. **C. tremellosa** Lloyd, Myc. Writ. 4. Myc. Notes 38: 516. *text f. 512, 513.* 1912. Plate 1, fig. 9.

Type: in Lloyd Herb. probably.

Fructifications coriaceous, soft, resupinate, at first circular, pezizoid, and with the thickened, paler margin slightly upturned, at length confluent, effused, and with the hymenial surface merulioid by the elevated confluent margins and reticulate veins, drying deep olive-buff to drab; hyphae with walls gelatinously modified, nodose-septate; basidia simple, with 2–4 sterigmata; spores white in spore collection, simple, even, 8–11 × 5–6 μ.

Fructifications at first 1–3 mm. in diameter, finally confluent over areas 3–8 × 3–5 cm.

On bark of decaying limbs of frondose species in low woods. Louisiana. November to June.

Although the young fructifications of *C. tremellosa* are decidedly pezizoid in aspect, yet, in the specimens seen by me, these small fructifications are in such close proximity to resupinate confluent masses of the same color that the resemblance to a *Merulius* is the more striking.

Specimens examined:

Louisiana: St. Martinville, *A. B. Langlois, 2620, 2670, aw, 594* (in N. Y. Bot. Gard. Herb., and Mo. Bot. Gard. Herb., 61681); *C. G. Lloyd, 2402* (in N. Y. Bot. Gard. Herb. and Burt Herb.).

SOLENIA

Solenia Persoon, Roemer Neues Mag. Bot. 1: 116. 1794; Syn. Fung. 675. 1801; Myc. Eur. 1: 334. 1822; Hoffman, Deutschl. Fl. 2: *pl. 8.* 1795; Fries, Syst. Myc. 2: 200. 1823; Hym. Eur. 595. 1874; Sacc. Syll. Fung. 6: 424. 1888; Engl. & Prantl, Nat. Pflanzenfam. (1:1**): 129. 1898; Rea, Brit. Basid. 701. 1922.

Fructifications coriaceous or membranaceous, sessile or nearly so, cylindric or turbinate, gregarious, fasciculate, rarely solitary, but not joined together except by confluence, seated on a superficial, felt-like, floccose and sometimes fugacious mycelium; basidia simple; spores white or colored.

The type species is *Solenia candida* Pers.

Solenia is closely related to *Cyphella* but differs from the latter by more numerous and less scattered fructifications which are more cylindric in the case of most species, and in having the gregarious fructifications seated on a more or less manifest mycelium. The

priority of Persoon's publication of *Solenia* is clearly established by Hoffmann's own work, for on the page of text following plate 8 he gives the full title of Persoon's work and its place of publication.

KEY TO THE SPECIES

Spores white 1
Spores colored .... *11. S. endophila*
    1. Fructifications white or but slightly cream-colored .... 2.
    1. Fructifications colored .... 3.
2. Fructifications white, scattered, cylindric, mouth not contracted; spores subglobose .... *1. S. candida*
2. Fructifications white, fasciculate, mouth contracted; spores subglobose .... *2. S. fasciculata*
2. Fructifications straw-color or shining white; in California.... *12. S. gracilis*
2. Fructifications white, crowded, confluent into a reticulate form; spores $4\frac{1}{2}$–5 × 4–$4\frac{1}{2}$ μ .... *3. S. polyporoidea*
2. Fructifications densely crowded, slightly tinted with cream; spores 4–6 × 2–3 μ .... *4. S. conferta*
2. Fructifications white, cylindric, villose; in Sweden .... *13. S. villosa*
    3. Fructifications ochraceous; spores 10–11 × $4\frac{1}{2}$ μ; on stems of ferns .... *5. S. filicina*
    3. Fructifications sulphur-colored; spores subglobose.... *6. S. sulphurea*
    3. Fructifications some shade of brown; spores 6–11 × $1\frac{1}{2}$–$4\frac{1}{2}$ μ .... *7. S. anomala*
    3. Fructifications pallid neutral gray, cylindric-clavate or pyriform; spores 9 × $5\frac{1}{2}$ μ; in California .... *8. S. cinerea*
    3. Fructifications cinereous, cup-shaped, sessile; spores $4\frac{1}{2}$–$6\frac{1}{2}$ × $4\frac{1}{2}$–5 μ .... *9. S. poriaeformis*
    3. Fructifications partially buried in the subiculum; spores 5–6 × 3 μ; in Venezuela .... *10. S. subporiaeformis*

1. **Solenia candida** Persoon, Roemer Neues Mag. Bot. **1**: 116. 1794; Syn. Fung. 676. 1801; Myc. Eur. **1**: 334. 1822; Hoffmann, Deutschl. Fl. **2**: *pl. 8, f. 1.* 1795; Fries, Syst. Myc. **2**: 200. 1823; Hym. Eur. 596. 1874; Sacc. Syll. Fung. **6**: 424. 1888; Bourdot & Galzin, Soc. Myc. Fr. Bul. **26**: 226. 1910; Rea, Brit. Basid. 702. 1922.

Fructifications scattered or solitary, 2–3 mm. high, cylindric, shining white, glabrous; spores hyaline, even, 4–5 × $3\frac{1}{2}$–4 μ.

On rotten wood, New York to Louisiana, and on palm in Bermuda. August to December. Rare.

The specimens which I have referred to *S. candida* are white when fresh but becoming pale pinkish buff in the herbarium, uniformly cylindric, often only 1 mm. long by 150 μ in diameter,

and notable by the mouths being nearly or quite the full diameter of the cavity of the fructification, as though the fructification were truncate. In Hoffmann's illustration, cited for *S. candida* by Persoon in his following works, the enlarged figure shows the fructifications as true cylinders with mouths open the full width of the cavity. In this figure the fructifications are enlarged to length of about 4 mm. and diameter of about 1 mm. and about the same distance apart as their length. In the collections which I refer to *S. candida*, the fructifications may be closer together than their length but always with small spaces between the fructifications, which are soft and crush easily under the cover glass in preparations.

Specimens examined:

New Hampshire: Hanover, *G. R. Lyman, 32* (in N. Y. Bot. Gard. Herb., and Mo. Bot. Gard. Herb., 61693).

New York: Buffalo, *G. W. Clinton* (in U. S. Dept. Agr. Herb., under the name *Solenia fasciculata*, and in Burt Herb.); East Galway, *E. A. Burt.*

Louisiana: St. Martinville, *A. B. Langlois, 1743.*

Bermuda: *S. Brown, N. L. Britton & F. J. Seaver, 1499* (in N. Y. Bot. Gard. Herb., and Mo. Bot. Gard. Herb., 61649).

2. **S. fasciculata** Persoon, Myc. Eur. **1**: 335. *pl. 12, f. 8* and *9.* 1822; Fries, Syst. Myc. **2**: 200. 1823; Hym. Eur. 596. 1874; Schweinitz. Am. Phil. Soc. Trans. N. S. **4**: 180. 1832; Morgan, Cincinnati Soc. Nat. Hist. Jour. **9**: 7. 1886; Sacc. Syll. Fung. **6**: 424. 1888; Bourdot & Galzin, Soc. Myc. Fr. Bul. **26**: 225. 1910; Rea, Brit. Basid. 702. 1922.—An *Solenia gracilis* Copeland, Ann. Myc. **2**: 508. 1904?

Fructifications gregarious and usually fasciculate, cylindric-clavate, somewhat enlarged towards the apex, 2–7 mm. high, white, minutely silky, almost smooth, sometimes rising from a thin, white mycelium; spores of European specimens white, even, 4–5½ × 3–4 μ, 4–6 × 3–5 μ in American specimens.

The specimens of *S. fasciculata* from France, sent to me by Bourdot and determined by him, have retained their white color for the seven years since gathered; they are seated on a white subiculum, common to the group of fructifications, and are

soft and easily crushed under the cover-glass in preparations and the hairs on the outside of the fructifications are colorless and soft in my preparations stained with eosin. The American specimens become pallid in the herbarium in a short time and may have spores slightly larger than European specimens. Two of our gatherings cited below have still the thin mycelium or subiculum, common to small groups of young fructifications; this apparently disappears as the fructifications become older and is not evident in most gatherings. The diameter of the mouth is somewhat smaller than that of the cavity into which it opens in this species, so that the apex is merely obtuse.

Specimens examined:

Exsiccati: Ellis, N. Am. Fungi, 937, under the name *Solenia villosa;* Ravenel, Fungi Car. 4: 21.

France: Loubotis, *A. Galzin, 18240, 18241*, comm. by H. Bourdot, 16094 and 15752 respectively.

Canada: Toronto, *J. H. Faull*, Univ. Toronto Herb., 640 (in Mo. Bot. Gard. Herb., 44909).

Vermont: Middlebury, *E. A. Burt*, three gatherings.

New York: Altamont, *E. A. Burt;* East Galway, *E. A. Burt.*

New Jersey: Newfield, Ellis & Harkness, in Ellis, N. Am. Fungi, 937.

Virginia: Mountain Lake, *W. A. Murrill, 403 in part* (in Mo. Bot. Gard. Herb., 54531).

South Carolina: *H. W. Ravenel*, in Ravenel, Fungi Car. 4: 21.

Florida: Daytonia, *R. Thaxter*, comm. by Farlow Herb., 234 (in Mo. Bot. Gard. Herb., 63044).

Louisiana: St. Martinville, *A. B. Langlois, 2998.*

3. **S. polyporoidea** Peck, Mss. n. sp.

Solenia villosa Fr. var. *polyporoidea* Peck, N. Y. State Mus. Rept. 41: 86. 1888.

Type: in N. Y. State Mus. Herb.

At first granuliform and distinct, finally confluent along the sides in contact and forming a more or less connected, reticulate layer with the bare wood showing in many little areas ½–1 mm. in diameter; no subiculum present; fructifications pure white, sessile, tubular, 700 μ long, 200–300 μ in diameter, about 5 to a

mm. where confluent, the free surfaces of the exterior clothed with weak, matted, hyaline, even hairs up to 30 μ long by 1 μ in diameter; spores copious, hyaline, even, subglobose, slightly flattened on one side, 4½–5 × 4–4½ μ.

Covering areas 3–7 cm. long, ½ cm. broad.

On decorticated, decaying wood of *Tsuga*. Adirondack Mountains, New York.

The hairs on the exterior are like ordinary hyphae of the walls and radiate outward only up to 30 μ rather than like the much larger, distinctive, external hairs of *C. fasciculata;* the cups are so firmly grown together that they are more or less mutilated and the walls torn in teasing the fructifications apart with needles under the dissecting microscope when immersed in water. This species is noteworthy by the confluence of the cups as well as by the matted, weak hairs.

Specimens examined:

New York: Adirondack Mts., *C. H. Peck,* type (in N. Y. State Mus. Herb.).

4. **S. conferta** Burt, n. sp.

Type: in Mo. Bot. Gard. Herb.

Fructifications crowded, sometimes up to 4 to a mm. and then somewhat confluent, cylindric, white with slight creamy tint, clothed with slender, appressed, even hairs 75 × 2½–3 μ, subhyaline, slightly yellowish in preparations stained with eosin; basidia simple, 12–15 × 4 μ, with 4 sterigmata; spores white in a spore collection, even, 4–6 × 2–3 μ.

Fructifications about 1 mm. high, 200–300 μ in diameter, covering areas 10 cm. or more in diameter.

On rotten wood. Alabama and Missouri. November.

This species may be only a small-spored form of *S. fasciculata* but it seems to me distinct by its fructifications becoming densely crowded and somewhat confluent, by the smaller spores, and by the hairs being slightly yellowish. It was distributed by Ravenel under the name *S. villosa,* with the European concept of which it does not agree. Where most densely crowded, the fructifications shrink apart in drying, showing bare areas of wood as in *S. polyporoidea* from which *S. conferta* differs in oblong

spores and larger, true, external hairs and less marked confluence of fructifications.

Specimens examined:

Exsiccati: Ravenel, Fungi Car. 5: 42, under the name *Solenia villosa.*

Alabama: *Peters*, in Ravenel, Fungi Car. 5: 42.

Missouri: Meramec Highlands, *L. O. Overholts*, type (in Mo. Bot. Gard. Herb., 14505).

5. **S. filicina** Peck, N. Y. State Mus. Rept. 28: 52. 1876; Sacc. Syll. Fung. 6: 426. 1888.

An *S. villosa* Fr? var., Bourdot & Galzin, Soc. Myc. Fr. Bul. 26: 225. 1910?

Type: in N. Y. State Mus. Herb.

"Cups springing from an ochraceous, white-margined, tomentose subiculum, elongated, clavate or cylindrical, deflexed, clothed with appressed hairs or tomentum, ochraceous; spores hyaline, broadly fusiform, containing one or two nuclei," even, 10–11 × 4½ μ; basidia simple.

Fructifications about 250–350 μ in diameter.

Base of living fern stems. Lake Pleasant, New York. August.

Peck noted that the basal part of the cups sometimes turns brown and shrinks in drying so that they appear stipitate. In the course of nearly fifty years, the subiculum and cups have become clay color with the margin paler. The hairs clothing the fructifications are only very slightly colored, even, flexuous, 75–85 × 3–3½ μ, tapering to a sharp tip; the spores are not curved but straight, with equal sides, tapering to both base and apex.

Specimens examined:

New York: Lake Pleasant, *C. H. Peck*, type (in N. Y. State Mus. Herb.).

6. **S. sulphurea** Saccardo & Ellis, Michelia 2: 564. 1882; Sacc. Syll. Fung. 6: 426. 1888.

Type: probably in Saccardo Herb., and N. Y. Bot. Gard. Herb.

Fructifications gregarious, sometimes rather crowded and up to 2–3 to a mm., cup-shaped, short-stemmed, sulphur-colored,

fading in the herbarium, strigose-pilose, the margin whitish fringed; hairs minutely rough, flexuous, 75–90 × 4–4½ μ, sharp-pointed; spores hyaline, even, subglobose, 6–7½ μ in diameter, copious.

Fructifications 250–400 μ in diameter and of about the same height.

On dead places in living trunk of *Magnolia glauca*. Newfield, New Jersey. January and April. Apparently local.

The specimens which I have seen were collected forty years ago and now show only traces of the original color, which is noted on the packets as "yellowish white when fresh, with white fringed margin, and disk white or nearly so." The larger globose spores should distinguish this species from *Cyphella sulphurea* and *C. laeta*.

Specimens examined:

New Jersey: Newfield, *J. B. Ellis*, four gatherings (in N. Y. Bot. Gard. Herb., Burt Herb., and Mo. Bot. Gard. Herb., 61697–61700).

7. **S. anomala** (Pers.) Fuckel, Symb. Myc., App. **1**: 290. 1872; Fries, Hym. Eur. 596. 1874; Sacc. Syll. Fung. **6**: 427. 1888; Bourdot & Galzin, Soc. Myc. Fr. Bul. **26**: 227. 1910; Rea, Brit. Basid. 702. 1922.

Peziza anomala Persoon, Obs. Myc. **1**: 29. 1796; Syn. Fung. 656. 1801; Fries, Syst. Myc. **2**: 106. 1823.—*P. stipata* Persoon, Myc. Eur. **1**: 270. 1822.—*Solenia ochracea* Hoffmann, Deutschl. Fl. **2**: *pl. 8, f. 2*. 1795; Persoon, Syn. Fung. 675. 1801; Myc. Eur. **1**: 334. 1822; Fries, Syst. Myc. **2**: 201. 1823; Hym. Eur. 596. 1874; Morgan, Cincinnati Soc. Nat. Hist. Jour. **9**: 8. 1886; Sacc. Syll. Fung. **6**: 425. 1888; Karsten, Finska Vet.-Soc. Bidrag Natur och Folk **48**: 283. 1889; Bourdot & Galzin, *loc. cit.*—*S. anomaloides* Peck, Torr. Bot. Club Bul. **25**: 326. 1898; Sacc. Syll. Fung. **16**: 173. 1902.—*S. anomala* var. *ochracea* (Hoffm.) Berk. in Rea, *loc. cit.*—An *S. confusa* Bresadola, Ann. Myc. **1**: 84. 1903?

Fructifications drying Dresden brown, snuff-brown, or Rood's brown, turbinate or pyriform, crowded or scattered, clothed with thick-walled hairs 2½–3 μ in diameter which give their color

to the fructifications and at the apex of the fructifications are often rough-walled near their tips; hymenium paler, urceolate, the margin incurved; basidia simple, with 4 sterigmata; spores hyaline, even, cylindric, curved, 6–11 × 1½–4½ μ.

Fructifications in dried condition ½–1 mm. high, 200–300 μ in diameter, where crowded 3–4 to a mm.

Usually crowded into small areas on pustules or crevices in the bark of dead twigs of *Alnus*, *Prunus*, *Quercus*, *Betula*, *Salix*, etc., or covering broad areas of decorticated wood, fewer and more scattered when the wood is very rotten. Throughout Europe, Newfoundland to Louisiana, westward to Oregon and British Columbia, and in Porto Rico. August to May. Common.

European specimens of *S. anomala* in the exsiccati cited below have somewhat larger spores than those of gatherings from eastern United States but do not differ at all from those of the extreme West. Those from British Columbia have spores 7–10 × 4–4½ μ and hairs rough near the tips, agreeing in both respects with the Westendorp distribution from Belgium. In one Colorado and one Montana gathering the spores are 3 μ thick, as in those of the Berkeley and the Libert distributions, and in another Colorado specimen 3–3½ μ thick as in the Cavara distribution. They are 2½ μ thick in two Montana gatherings and in the Rabenhorst distribution, although many of the latter are only 2 μ thick as is the usual thickness of spores of New York and New England gatherings. In my opinion these spore differences do not warrant specific distinction, and I doubt furthermore whether *S. confusa* of Europe, separated from *S. anomala* on the sole ground of spores 7–10 × 2–2½ μ, is really distinct from the latter. The distributions by Berkeley, Libert, and Cavara are true intermediates.

Specimens examined:

Exsiccati: Bartholomew, Fungi Col., 2085, under the name *S. ochracea;* Berkeley, Brit. Fungi, 260; Cavara, Fungi Longobardiae, 108; Cooke, Fungi Brit., 405, under the name *S. ochracea;* Desmazières, Crypt. France, 1059; Ellis, N. Am. Fungi, 611, under the name *S. ochracea;* Reliquiae Farlowianae, 363; Karsten, Fungi Fenniae Exs., 7; Kunze, Fungi Sel. Exs., 301; Libert, Pl. Crypt. Arduennae, 22*i*; Rabenhorst, Herb.

Myc., 307; Ravenel, Fungi Car. 4: 7; Saccardo, Myc. Veneta, 1407, 1408; Sydow, Fungi Exotici, 323; Westendorp, Herb. Crypt. Belge, 398.

Finland: *P. Karsten*, in Karsten, Fungi Fenniae Exs., 7.

Sweden: Tyroso, *L. Romell, No. A in part.*

Germany: Dresden, in Rabenhorst, Herb. Myc., 307.

Austria: Sonntagberg, *P. Strasser* (in Mo. Bot. Gard. Herb., 42683).

Switzerland: *G. Winter*, in Kunze, Fungi Sel. Exs., 301.

Italy: Padua, in Cavara, Fungi Longobardiae, 108; in Saccardo, Myc. Veneta, 1407, 1408.

France: in Desmazières, Crypt. France, 1059; in Libert, Pl. Crypt. Arduennae, 227.

Belgium: Bruges, in Westendorp, Herb. Crypt. Belge, 398.

England: in Berkeley, Brit. Fungi, 260; Shrewsbury, *W. Phillips*, in Cooke, Fungi Brit., 405, under the name *S. ochracea.*

Newfoundland: Bay of Islands, *A. C. Waghorne* (in Mo. Bot. Gard. Herb., 4601).

Canada: Ontario, Kenora, *A. H. R. Buller, 559* (in Mo. Bot. Gard. Herb., 58979); London, *J. Dearness*, in Bartholomew, Fungi Col., 2085, and Sydow, Fungi Exotici, 323.

Maine: Kittery Point, *R. Thaxter & E. A. Burt.*

Vermont: Middlebury, *E. A. Burt*, three collections.

Massachusetts: Arlington, *E. A. Burt;* Cambridge, *M. A. Barber;* Milton, *H. Webster, 800;* Newton, *M. A. Barber* (in Mo. Bot. Gard. Herb., 3913); Sharon, *W. G. Farlow* (in Mo. Bot. Gard. Herb., 62749); *A. P. D. Piguet*, in Reliquiae Farlowianae, 363.

New York: Bronx Park, *W. A. Murrill* (in N. Y. Bot. Gard. Herb., and Mo. Bot. Gard. Herb., 61688); Syracuse, *A. H. W. Povah, 890* (in Mo. Bot. Gard. Herb., 58175); *L. M. Underwood* (in N. Y. Bot. Gard. Herb., and Mo. Bot. Gard. Herb., 61690); White Plains, *L. M. Underwood* (in Mo. Bot. Gard. Herb., 61687).

Pennsylvania: Bethlehem, *Ellis & Harkness*, in Ellis, N. Am. Fungi, 611.

South Carolina: *H. W. Ravenel*, in Ravenel, Fungi Car. 4: 20.

Louisiana: St. Martinville, *A. B. Langlois.*

Michigan: *Beal, 214*, type of *Solenia anomaloides* (in N. Y. State Mus. Herb.).

Iowa: Webster County, *O. M. Oleson, 446* (in Mo. Bot. Gard. Herb., 14556); Woodbine, *Humphrey & Edgerton*, comm. by C. J. Humphrey, 6510 (in Mo. Bot. Gard. Herb., 42920).

Missouri: Concordia, *Demetrio* (in Mo. Bot. Gard. Herb., 4592); Creve Coeur, *S. M. Zeller, 1567* (in Mo. Bot. Gard. Herb., 55567).

Nebraska: Lincoln, *L. B. Walker* (in Mo. Bot. Gard. Herb., 55016).

Colorado: Geneva, *F. J. Seaver & E. Bethel* (in N. Y. Bot. Gard. Herb., and Mo. Bot. Gard. Herb., 61692); Tolland, *F. J. Seaver & E. Bethel* (in N. Y. Bot. Gard. Herb., and Mo. Bot. Gard. Herb., 61691).

Montana: Choteau, *J. A. Hughes*, comm. by J. R. Weir, 5489 (in Mo. Bot. Gard. Herb., 55947); Helena, *F. D. Kelsey* (in Mo. Bot. Gard. Herb., 62750); Missoula, *J. R. Weir, 424* (in Mo. Bot. Gard. Herb., 22430); Sheridan, *Miss Fitch* (in N. Y. Bot. Gard. Herb., and Mo. Bot. Gard. Herb., 61689).

Oregon: Corvallis, *S. M. Zeller, 2064* (in Mo. Bot. Gard. Herb., 57504).

British Columbia: Sidney, *J. Macoun, 67* (in Mo. Bot. Gard. Herb., 5745); Victoria, *J. Macoun, 563* (in Mo. Bot. Gard. Herb., 55308).

Porto Rico: Rio Piedras, *J. A. Stevenson & R. C. Rose, 6532* (in Mo. Bot. Gard. Herb., 55657).

Jamaica: Chester Vale, *W. A. & E. L. Murrill, 347*, comm. by N. Y. Bot. Gard. Herb.

8. S. cinerea Burt in Millspaugh & Nuttall, Flora Santa Catalina Island, 315. 1922.

Type: in Field Mus. Nat. Hist. Herb. and Mo. Bot. Gard. Herb.

Fructifications cespitose, 30–100 in dense circular clusters on cracks and pustules of the bark, short-stipitate, cylindric-clavate or pyriform, pallid neutral gray of Ridgway, minutely hairy, the apex obtuse and pore nearly closed; surface hairs colored, flexuous, $100 \times 3\frac{1}{2}$ μ, paler towards the tips and there rough-

walled; basidia simple, 30 × 6 μ, with 4 slender sterigmata; spores hyaline, even, cylindric or slightly curved, 7½–10 × 4–5½ μ, usually 9 × 5½ μ.

Fructifications 700 μ high, 200–300 μ in diameter.

On bark of rotting oak. California. May.

The fructifications are colored like those of *S. poriaeformis* but in other respects are more like *S. anomala* when growing on pustules and crevices of the bark.

Specimens examined:

California: Avalon, Santa Catalina Island, *L. W. Nuttall, 396*, type (in Field Mus. Nat. Hist. Herb., and Mo. Bot. Gard. Herb., 57610).

9. **S. poriaeformis** (Pers.) Fries, Hym. Eur., 597. 1874; Winter in Rabenhorst, Krypt.-Fl. 1: 391. 1884; Bourdot & Galzin, Soc. Myc. Fr. Bul. 26: 226. 1910.

Peziza poriaeformis Pers. γ of *Peziza anomala* Pers. Syn. Fung. 656. 1801.—*P.? poriaeformis* (Pers.) De Candolle, Fl. France 6: 26. 1815; Fries, Syst. Myc. 2: 106. 1823.—*P. tephrosia* Pers. Myc. Eur. 1: 271. 1822.—*Solenia poriaeformis* (DC.) Fuckel, Symb. Myc. App. 1: 290. 1872.—Sacc. Syll. Fung. 6: 428. 1888; Coker, Elisha Mitchell. Scientif. Soc. Jour. 36: 151. *pl. 15, pl. 30. f. 4–6.* 1921; Rea, Brit. Basid. 703. 1922.—An *Peziza pruinata* Schweinitz, Naturforsch. Ges. Leipzig Schrift. 1: 120. 1822?—An *P. Daedalea* Schweinitz, Am. Phil. Soc. Trans. N. S. 4: 174. 1832?

Illustrations: Brefeld, Untersuch. Myk. 7: *pl. 11, f. 21.* 1888; Coker, *loc. cit.*

Fructifications about 1 mm. high, cinereous, light neutral gray or hair-brown, cup-shaped, sessile, hairy, more or less crowded, 2–4 to a mm., seated on a grayish mycelium; hymenium pale gray, concave; flesh thin, brownish; basidia simple, with 2–4 sterigmata; spores hyaline, even, subglobose, 4½–6½ × 4½–5 μ.

On decaying limbs and logs of frondose species. Europe, New Jersey to Alabama, and in Minnesota. April to January. Infrequent.

This species covers small areas 1–3 cm. long by ½–1 cm. broad on bark of oak, birch, maple, grape, etc. It has the aspect of a

cinereous, crustaceous lichen bearing numerous small apothecia. It is distinguished from *S. subporiaeformis* by larger cups and more globose spores. I failed to study the authentic specimens of *Peziza Daedalea* Schw. and *Peziza pruinata* Schw. when there was an opportunity.

Specimens examined:

Exsiccati: Ell. & Ev., N. Am. Fungi, 2317; Jaap, Fungi Sel. Exs., 65; Ravenel, Fungi Car. 1: 38, under the name *Peziza pruinata* Schw.; Ravenel, Fungi Car. 1: 37, under the name *Peziza Daedalea* Schw.

Sweden: Femsjö, *L. Romell.*

Germany: Brandenburg, in Jaap, Fungi Sel. Exs., 65.

France: Aveyron, *A. Galzin, 1784,* comm. by H. Bourdot, 4747.

New Jersey: Newfield, *J. B. Ellis,* in Ell. & Ev., N. Am. Fungi, 2317.

Maryland: Takoma Park, *C. L. Shear, 1087.*

North Carolina: Chapel Hill, *W. C. Coker, 4686* (in Mo. Bot. Gard. Herb., 57331).

South Carolina: *H. W. Ravenel,* in Ravenel, Fungi Car. 1: 37, 38.

Alabama: Auburn, *F. S. Earle* (in N. Y. Bot. Gard. Herb., and Mo. Bot. Gard. Herb., 57330).

Minnesota: Vermilion Lake, *E. W. D. Holway* (in U. S. Dept. Agr. Herb., Burt Herb., and Mo. Bot. Gard. Herb., 4800), and *J. C. Arthur, L. H. Bailey & E. W. D. Holway, 2548* (in Mo. Bot. Gard. Herb., 4599).

10. S. subporiaeformis Burt, n. sp.

Type: in Farlow Herb. and Mo. Bot. Gard. Herb.

Fructifications spherical, 120–150 μ in diameter, 4–5 to a mm., nearly buried in the pale neutral gray subiculum, with the white mouths and adjacent portion of the wall protruding; mouth about 60–80 μ in diameter; hymenium black as seen from above, the subhymenium opaque, nearly black; basidia simple, pyriform, 9–12 × 5–6 μ; spores hyaline, even, flattened on one side, 5–6 × 3 μ.

Fructifications in small patches 4 × 3 cm., 3 × 2 cm., and 3 × 1½ cm. in the three specimens collected.

On decorticated, very rotten wood. Margarita Island, Venezuela. July.

This species is closely related to *S. poriaeformis*, but may be distinguished from the latter by smaller, partially buried fructifications, smaller basidia, and smaller spores of elongated rather than subglobose form. It may possibly range farther north into the West Indies.

Specimens examined:

Venezuela: Margarita Island, *A. F. Blakeslee*, type (in Farlow Herb., and Mo. Bot. Gard. Herb., 56064).

11. **S. endophila** (Ces.) Fries, Hym. Eur. 705. 1874; Sacc. Syll. Fung. 6: 427. 1888.

Cyphella endophila Cesati in Rabenhorst, Fungi Eur., 1513, with description. 1872; Mattirolo, Accad. Scienze Torino Atti 22:—*pl. 4*. 1887.

Type: type distribution in Rabenhorst, Fungi Eur., 1513.

Fructifications densely crowded together, curving upward from a continuous carpet (often evanescent) of short, suberect, colored hyphae, furfuraceous-villose, at first whitish, becoming ochraceous when old, attenuated towards the base into a short stem; the disk rather pale; hairs colored, even, flexuous, 40–45 $\times$ 3–4½ μ; basidia simple, 12–14 $\times$ 4½–5 μ; spores colored, even, 6–7 $\times$ 4–5 μ, copious.

Fructifications 1 mm. long, 200–300 μ in diameter, usually somewhat scattered but crowded in some places up to 2–3 to a mm.

On rotten, decorticated wood and bark of *Populus* and other frondose species. Southern Europe, Maine, Vermont, Florida, Colorado, and South America. August to March. Rare.

A great deal of powdery matter covers the hairy fructification and is the cause of its whitish color. *S. endophila* is readily distinguished from our other species by its colored spores.

Specimens examined:

Exsiccati: Rabenhorst, Fungi Eur., 1513, type distribution; Theissen, Dec. Fung. Brasilium, 165.

Italy: *Cesati*, in Rabenhorst, Fungi Eur., 1513.

Maine: Kittery Point, *R. Thaxter*, comm. by W. G. Farlow, 1 (in Mo. Bot. Gard. Herb., 43804).

Vermont: Middlebury, *E. A. Burt.*
Florida: Palm Beach, *R. Thaxter*, comm. by Farlow Herb., 247 (in Mo. Bot. Gard. Herb., 63046).
Colorado: Denver, *F. J. Seaver & E. Bethel* (in N. Y. Bot. Gard. Herb., Burt Herb., and Mo. Bot. Gard. Herb., 61695).
Venezuela: Margarita Island, *A. F. Blakeslee*, comm. by Farlow Herb. (in Mo. Bot. Gard. Herb., 56067).
Brazil: *Rick*, in Theissen, Dec. Fung. Brasilium, 165.

SPECIES IMPERFECTLY KNOWN

12. **S. gracilis** Copeland, Ann. Myc. **2**: 508. 1904; Sacc. Syll. Fung. **21**: 362. 1912.

"Sparsa; cupulis primo urceolatis, brevissime stipitatis, demum cylindraceis, denique late sessilibus, sursum attenuatis, oribus incrassatis, integris, glabris, stramineis nitentibus, vel candidis et deorsum fuscescentibus, 0.5 mm. altis; sporis globosis, 7.5–8 μ diam.

"Ad lignum putridum *Alni*. Saratoga." [California.]

13. **S. villosa** Fries, Syst. Myc. **2**: 200. 1823; Hym. Eur. 596. 1874; Schweinitz, Am. Phil. Soc. Trans. N. S. **4**: 180. 1832; Sacc. Syll. Fung. **6**: 425. 1888.

Fructifications gregarious, cylindric, villose, white. Related to the preceding species (*S. candida, S. fasciculata, S. pallens*) but a little larger, distinctly villose, by this approaching *S. ochracea*. On fallen rotten wood.

The above is a translation of the original description, to which I have found no distinctive additions from later European research. The description is given here because American mycologists have so frequently referred gatherings to *S. villosa*, a species which seems to be imperfectly known in its own country.

MATRUCHOTIA, MICROSTROMA, PROTOCORONOSPORA

Matruchotia varians Boulanger, Rev. Gen. Bot. **5**: 401. *pl. 12–14.* 1893; Rev. Myc. **16**: 68. *pl. 142–144.* 1894. Sacc. Syll. Fung. **11**: 118. 1895.

Under the above name Boulanger described as a new genus and new species a fungus of soft consistency and aspect of the

Hyalostilbeae but having spores borne one or two to a sporophore—usually but one. This fungus appeared in cultures of the bark of *Piscidia erythrina*, used in pharmacy and obtained from South America northward to Florida. On account of sometimes two spores to a spore-bearing cell Boulanger would class *Matruchotia* as a Basidiomycete—as an intermediate connecting the Basidiomycetes with the Hyphomycetes and showing their phylogenetic origin from the latter.

The account and illustrations present *Matruchotia* as having an erect trunk composed of cohering hyphae, branched above, and bearing spores along the sides of the trunk and branches and at the tips of the final branchlets.

I am disposed to regard *Matruchotia* as a genus of the *Stilbiaceae* and do not attach great importance to the fact that the spores are sometimes in twos.

The range of *Matruchotia* is northward to Maine at least and on other kinds of wood than *Piscidia*, for while collecting at Kittery Point with Professor Thaxter we found plentifully there a soft, white, mucedinous fungus which he recognized as *Matruchotia.*

Microstroma Niessl, Mähr. Crypt. Fl., 163. 1861; Sacc. Syll. Fung. 4: 9. 1886; Engl. & Prantl, Nat. Pflanzenfam. (1:1**): 105. 1898.

This genus is represented in North America by *M. albus*, *M. Juglandis*, *M. leucosporum*, *M. americanorum*, and *M. ingainicola.* The more frequent species occur as small white patches on living leaves of *Carya*, *Juglans*, *Quercus*, etc. Some authors have referred *Microstroma* to the Basidiomycetes on account of several spores being produced at the apex of the spore-bearing cell. R. Maire, Rec. publ. Occ. Jubilé sc. Prof. Le Monnier 131–139. 1913, concludes that *Microstroma* is not a Basidiomycete but one of the *Melanconieae.*

Protocoronospora Atkinson & Edgerton, Jour. Myc. 13: 186. 1907; Sacc. Syll. Fung. 21: 421. 1912; Wolf, Elisha Mitchell Scientif. Soc. Jour. 36: 82. 1920.

The type species, *Protocoronospora nigricans* Atk. & Edg., is a virulent parasite on all parts above ground, including the pods, of *Vicia sativa* and *V. villosa*. *Protocoronospora* was proposed as

a genus of the *Thelephoraceae* because the spores are borne in a whorl at the apex of the spore-bearing cell. Wolf, *loc. cit.*, has presented the morphology and development of *P. nigricans* and concludes that *Protocoronospora* is not a Basidiomycete but one of the *Melanconieae*, a conclusion in which I concur.

ASTEROSTROMA

Asterostroma Massee, Linn. Soc. Bot. Jour. 25: 154. *pl. 46, f. 8, 9.* 1889; Sacc. Syll. Fung. 9: 236. 1891; Engl. & Prantl, Nat. Pflanzenfam. (1:1**): 122. 1898; Bourdot & Galzin, Soc. Myc. Fr. Bul. 36: 44. 1920.

Fructifications resupinate, effused, dry, composed of loosely interwoven hyphae, some of which terminate in brown, stellate organs composed of slender rays; basidia simple, with 2–4 sterigmata; spores hyaline.

The species of *Asterostroma* are likely to be referred to *Corticium* unless sections are examined. In sections the brown, stellate organs are conspicuous when viewed with the microscope and sharply separate *Asterostroma* from other resupinate thelephoraceous fungi. Similar organs occur, however, in *Asterodon* of the *Hydnaceae* and in a species of *Lachnocladium*.

Key to the Species

No colored hyphae present in the subiculum..............................1
Some colored hyphae in subiculum........................*6. A. ochrostroma*
1. Spores becoming echinulate..............................2
1. Spores even..............................3
2. Stellate organs with unbranched rays as a rule..............*1. A. cervicolor*
2. Many stellate organs have some rays branched............*2. A. muscicolum*
3. Hymenium drying whitish; no cystidia; rays 3½–4½ μ in diameter..............................*3. A. bicolor*
3. Like *A. bicolor* except that rays up to 130 × 9 μ protrude beyond hymenium, like setae..............................*4. A. spiniferum*
3. Stellate organs have notably long, slender rays up to 100–150 × 3–3½ μ; fructification not spongy..................*5. A. gracile*

1. **Asterostroma cervicolor** (Berk. & Curtis) Massee, Linn. Soc. Bot. Jour. 25: 155. 1889; Sacc. Syll. Fung. 9: 237. 1891; Bourdot & Galzin, Soc. Myc. Fr. Bul. 36: 44. 1920.

Corticium cervicolor Berk. & Curtis, Grevillea 1: 179. 1873; Sacc. Syll. Fung. 6: 621. 1888.—*Asterostroma corticola* Massee, Linn. Soc. Bot. Jour. 25: 155. 1889; Sacc. Syll. Fung. 9: 236.

1891.—*A. albido-carneum* Massee, Linn. Soc. Bot. Jour. 25: 155. *pl. 46. f. 8, 9.* 1889. Not *Thelephora albido-carnea* Schweinitz, Am. Phil. Soc. Trans. N. S. 4: 169. 1832.—*A. pallidum* Morgan, Cincinnati Soc. Nat. Hist. Jour. 18: 38. *pl. 1, f. 6.* 1895; Sacc. Syll. Fung. 14: 223. 1899.

Type: in Kew Herb. and Curtis Herb.

Fructification effused, thin, spongy, dry, avellaneous to cinnamon-drab within, the margin fibrillose-floccose, paler; hymenium even, pulverulent, becoming pallid where well-fruited; structure in section 150–300 μ thick, composed of thin-walled, loosely arranged, hyaline hyphae 2–2½ μ in diameter and of conspicuous, colored, thick-walled, rigid, stellate organs with 3–7, usually about 5, unbranched rays 15–60 μ long and 3–3½ μ in diameter, distributed throughout the fructification; cystidia (gloeocystidia?) fusoid, often sharp-pointed, not incrusted, 30–45 × 8–12 μ, protruding up to 25 μ above the basidia; basidia simple, with 4 sterigmata; spores white in spore collections, spherical, becoming echinulate, with the spore body 4–5 μ in diameter.

On decaying wood, earth, and on outside of a flower pot. Canada to Louisiana, in Washington, California, Mexico, West Indies, and Japan. July to March. Widely distributed but not abundant.

The color of this species varies somewhat with the presence and degree of development of the hymenium; young fructifications still lacking basidia or with only few scattered basidia have a tawny color due to the numerous colored stellate bodies which are present in the surface of the fructification. As the hymenium becomes continuous in patches or over the whole surface it conceals the stellate organs and shows as a whitish or pallid pellicle in the regions where developed, with comparatively few colored rays protruding through it. The type specimen of *A. pallidum* has the hymenium fully developed. Under my method of staining sections with eosin and then preserving in glycerine mounts, the fusoid organs in the hymenium are what I understand as non-incrusted cystidia containing little granular matter, a great deal of cell sap, and with such thin walls that they collapse in the glycerine preparations. Bourdot has a special reagent and method which he employs as a test for gloeocystidia, and he has decided that these organs are gloeocystidia.

The specimens of *A. ochroleuca* Bres. from France, communicated by Bourdot, seem to me specifically distinct from our *A. cervicolor* by their lack of the continuous, whitish hymenial pellicle and the abundant rays in the hymenial surface being well branched so that very many of them resemble antlers rather than stellate organs.

Specimens examined:

Exsiccati: Ravenel, Fungi Am., 228, under the name *Corticium cervicolor;* Ravenel, Fungi Car. 4: 14, type distribution of *Asterostroma albido-carneum* Massee, under the name *Corticium albido-carneum* but not the species of Schweinitz.

Canada: St. Lawrence Valley, *J. Macoun, 18.*

New Hampshire: Chocorua, *E. A. Burt,* two collections; *W. G. Farlow, 2a, 2b,* an unnumbered specimen in Burt Herb., and *2, 3, 155* and an unnumbered specimen (in Mo. Bot. Gard. Herb., 55601, 55602, 55246, and 6883 respectively).

Massachusetts: Belmont, *W. G. Farlow.*

New York: Albany, *H. D. House & J. Rubinger* (in N. Y. State Mus. Herb., and Mo. Bot. Gard. Herb., 6327); East Galway, *E. A. Burt.*

Pennsylvania: Bethlehem, *Schweinitz* (in Herb. Schweinitz under the names *Thelephora reticulata* and *Thelephora mollis*).

District of Columbia: Washington, *J. R. Weir, 19741* (in Mo. Bot. Gard. Herb., 59167).

South Carolina: *H. W. Ravenel,* in Ravenel, Fungi Car. 4: 14.

Georgia: Darien, *H. W. Ravenel,* in Ravenel, Fungi Am., 228.

Florida: *W. W. Calkins, 150,* comm. by W. G. Farlow (in Mo. Bot. Gard. Herb., 44635); Cutler Hammock, *W. A. Murrill, 85* (in N. Y. Bot. Gard. Herb., and Mo. Bot. Gard. Herb., 62104).

Alabama: *Peters,* type of *Corticium cervicolor* (in Curtis Herb., 4026, and Kew Herb.); Montgomery County, *R. P. Burke, 110* and *311* (in Mo. Bot. Gard. Herb., 19896 and 57185 respectively).

Louisiana: St. Martinville, *A. B. Langlois, cx, 1948, 203* (in Burt Herb., Lloyd Herb., 3144, and Mo. Bot. Gard. Herb., 55621).

Ohio: Cincinnati, *C. G. Lloyd.*

Idaho: Priest River, *J. R. Weir, 581* (in Mo. Bot. Gard. Herb., 63172).

Washington: Hoquiom, *C. J. Humphrey, 6411.*

California: *A. J. McClatchie*, type of *Asterostroma pallidum* (in Kew Herb., and Mo. Bot. Gard. Herb., 4792).

Mexico: Xuchiles, near Cordoba, *W. A. & E. L. Murrill, 1206, 1212*, comm. by N. Y. Bot. Gard. Herb. (in Mo. Bot. Gard. Herb., 54593 and 54594 respectively); near Guernavaca, *W. A. & E. L. Murrill, 516*, comm. by N. Y. Bot. Gard. Herb. (in Mo. Bot. Gard. Herb., 54517); Jalapa, *W. A. & E. L. Murrill, 300*, comm. by N. Y. Bot. Gard. Herb. (in Mo. Bot. Gard. Herb., 54444).

Porto Rico: Central Alianga, *J. A. Stevenson, 6071* (in Mo. Bot. Gard. Herb., 54684); Rio Piedras, comm. by Mrs. F. W. Patterson.

Japan: Awaji, Mt. Mikuma, *A. Yasuda, 38* (in Mo. Bot. Gard. Herb., 56170).

2. **A. muscicolum** (Berk. & Curtis) Massee, Linn. Soc. Bot. Jour. 25: 155. 1889.

Hymenochaete muscicola Berk. & Curtis, Linn. Soc. Bot. Jour. 10: 334. 1868; Sacc. Syll. Fung. 6: 602. 1888.

Type: in Kew Herb. and Curtis Herb.

Fructification broadly effused, thin, spongy, dry, wood-brown of Ridgway, the margin narrow, whitish; hymenium concolorous with the subiculum or but slightly paler, even; in structure in section 300–400 μ thick, composed of thin-walled, loosely arranged hyaline hyphae and of very numerous, colored, stellate organs with 3–9 rays, the rays about $30–45 \times 3–4\frac{1}{2}$ μ, sometimes unbranched but many branched, becoming smaller and more branched towards, and in, the hymenium and bearing secondary whorls of small branches or with 2 stellate organs connected by a short, thick axis; cystidia few, not incrusted, 6 μ in diameter, protruding up to 27 μ, tapering to a sharp point; spores hyaline, spherical, echinulate, the body 5–7 μ in diameter, the spines numerous, close together, very distinct.

Fructifications up to 7×4 cm. when well developed.

On dead branches of trees covered with moss, on cocoanut

petioles, and on rotting wood. West Virginia, Arkansas, Louisiana, and the West Indies. July to December.

A. muscicolum has so many tough, stellate organs that it is not easy to cut sections free hand which are thin enough to show clearly the details of the hymenium; it differs in this respect from *A. cervicolor* and also by the very numerous, branched rays and the thicker-walled spores covered with stouter and more numerous spines.

Specimens examined:

West Virginia: Eglon, *C. G. Lloyd, 1457* (in Mo. Bot. Gard. Herb., 55611).

Louisiana: *Dr. Hale* (under the name *Stereum Halei* in Kew Herb. and Curtis Herb., 3660); St. Martinville, *A. B. Langlois, 2703.*

Arkansas: Fordyce, *C. J. Humphrey, 2530* (in Mo. Bot. Gard. Herb., 11952).

Cuba: *C. Wright, 253,* type of *Hymenochaete muscicola* (in Kew Herb. and Curtis Herb.); Ceballos, *C. J. Humphrey, 2579* (in Mo. Bot. Gard. Herb., 14841); Habana Province, Fecha, *F. S. Earle, 141.*

Grenada: Grand Etang, *R. Thaxter,* comm. by W. G. Farlow, 15.

3. **A. bicolor** Ellis & Everhart, Acad. Nat. Sci. Philadelphia Proc. **1893**: 441. 1893; Sacc. Syll. Fung. **11**: 128. 1895.

Type: in N. Y. Bot. Gard. Herb., U. S. Dept. Agr. Herb., and Burt Herb.

Effused, thin, avellaneous when fresh, the hymenium becoming whitish in the herbarium, the margin thin, cobwebby; in structure in section 200–300 μ thick, composed of loosely arranged, hyaline hyphae 2–2½ μ in diameter and of rather scattered—not crowded—colored, stellate organs with unbranched rays 45–120 μ long, 3½–4½ μ in diameter; no cystidia; basidia with 4 sterigmata; spores white in a spore collection, even, globose, apiculate at the base, 5–7 μ in diameter.

Fructifications 1–6 cm. long, 1–4 cm. broad.

On rotten wood of both frondose and coniferous species but more abundant on the latter. New York to Louisiana and westward to British Columbia. August to November.

Specimens of *A. bicolor* acquire in the herbarium the whitish hymenium of a well-fruited *A. cervicolor* from which they are only distinguishable by the even spores and the absence of cystidia. On the basis of the similar spores, I formerly referred to *A. bicolor* a small specimen collected in Sweden by Romell. Bourdot has recently sent to me from France several specimens, published by him under the name *A. laxum* Bres., which are identical in structure with the specimen from Romell and constantly distinct from our *A. bicolor* by having occasional cystidia and stellate organs with branched rays—so conspicuously branched in the hymenium as to approach antler form.

Specimens examined:

New York: Floodwood, *E. A. Burt.*

Delaware: Wilmington, *Commons, 2356*, type (in N. Y. Bot. Gard. Herb., U. S. Dept. Agr. Herb., and Burt Herb.).

Maryland: Glen Sligo, *C. L. Shear, 1141.*

Louisiana: St. Martinville, *A. B. Langlois, ac.*

Kentucky: Crittenden, *C. G. Lloyd* (in Lloyd Herb., 1401, 1425, and Mo. Bot. Gard. Herb., 55616 and 55617 respectively).

Illinois: Christopher, *C. J. Humphrey, 1991* (in Mo. Bot. Gard. Herb., 59018).

British Columbia: Kootenai Mts., near Salmo, *J. R. Weir, 454, 495, 520, 541* (in Mo. Bot. Gard. Herb., 13274, 21977, 19438, and 3774 respectively).

4. **A. spiniferum** Burt, n. sp.

Type: in Mo. Bot. Gard. Herb.

Fructifications effused, with the subiculum avellaneous and the hymenium pale pinkish buff; in structure 300–350 μ thick, with hyphae hyaline, arranged longitudinally along the substratum and passing into a loosely arranged layer and becoming intermixed with the colored, stellate organs; stellate organs not densely crowded together, with unbranched rays 50–90 × 6–7 μ usually, but next to the hymenium having rays perpendicular to the latter, larger than the other rays, up to 130 × 9 μ, and protruding beyond the basidia up to 110 μ, like setae; cystidia not incrusted, 25 × 5 μ, sparingly present; spores hyaline, even, subglobose, 5–6 μ in diameter.

Fructifications up to 4 cm. long, 2 cm. broad.

On rotten wood. Porto Rico. July.

This species is related to *A. bicolor* but is distinct from the latter and noteworthy by the very large, unsymmetrical, seta-like rays which stand out above the general level of the hymenium. The occasional cystidia are an additional separating character.

Specimens examined:

Porto Rico: Rio Piedras, *J. A. Stevenson, 5579*, type (in Mo. Bot. Gard. Herb., 13415).

5. **A. gracile** Burt, n. sp.

Type: in Mo. Bot. Gard. Herb.

Fructifications effused, very thin, cobwebby, delicate, with the subiculum light drab and the hymenium pale olive-buff, not continuous but with the basidia in clusters; in structure 150 μ thick, with hyphae loosely arranged, hyaline, 2–2½ μ in diameter, and with colored, stellate organs with central body 6 μ in diameter and very slender, unbranched rays up to 100–150 × 3–3½ μ, often protruding beyond the hymenium up to 45 μ; cystidia numerous, not incrusted, fusoid, 30 × 8 μ; basidia 15 × 6 μ; spores hyaline, even, spherical, 6 μ in diameter.

Fructifications ½–1 cm. in diameter.

On very rotten, frondose wood. Alabama. October.

The small gray fructifications of *A. gracile* have the aspect of a delicate, cobwebby Hyphomycete rather than the more compact, spongy structure of other species of this genus. The long, slender rays of the stellate organs and the cystidia are also distinctive.

Specimens examined:

Alabama: Montgomery County, *R. P. Burke, 409*, type (in Mo. Bot. Gard. Herb., 57202).

6. **A. ochrostroma** Burt, n. sp.

Type: in Mo. Bot. Gard. Herb., and Farlow Herb. probably.

Fructification effused, dry, felty, ochraceous tawny, with surface becoming shallowly granular in fruiting; in structure 200–300 μ thick, composed of both hyaline, thin-walled, flaccid hyphae 2 μ in diameter, and of some ochraceous, stiff, thick-walled hyphae 2 μ in diameter, and of very numerous, densely

crowded stellate organs of varying size; stellate organs with unbranched rays 20–60 × 3–6 μ which protrude beyond the hymenium in such great numbers and so crowded as to nearly conceal the basidia; no cystidia found; basidia simple, 10 × 5 μ, with 4 sterigmata, but few basidia found; floating spores in each preparation are hyaline, even, 4–4½ × 3 μ, neither copious nor seen attached to basidia.

Fructifications 1–1½ mm. long, about ½ mm. broad.

On bark and decorticated wood of *Abies*. New Hampshire. September.

A. ochrostroma differs from all other species of *Asterostroma* known to me by the presence in its subiculum of some slender, rigid, thick-walled hyphae of the same diameter as the usual, thin-walled hyphae but of the same color as the stellate organs. I find these colored hyphae more abundant in the sterile portions of the fructification; they have bleached in sections preserved for several years in glycerine mounts. The stellate organs are more numerous than in any other of our species and prevent cutting satisfactorily thin sections of the hymenium by free hand. Some hyaline, even spores 4–4½ × 3 μ were found floating in each preparation but not abundantly and are probably the spores of this species.

Specimens examined:

New Hampshire: Crystal Cascade, White Mts., *W. G. Farlow, 1*, type (in Mo. Bot. Gard. Herb., 55578).

(*To be continued*)

Explanation of Plate

PLATE 1

Fig. 1. *Cladoderris dendritica.* *a*, showing upper side, collected in Cuba by W. A. & E. L. Murrill, 136; *b*, showing ribbed hymenium, collected in Colombia by W. D. Denton.

Fig. 2. *C. floridana.* Part of type, showing warts of hymenium, collected in Florida.

Fig. 3. *Skepperia spathularia.* After Patouillard.

Fig. 4. *Hypolyssus Montagnei.* *a*, collected in Bolivia by A. M. Bang; *b*, collected in Honduras by P. Wilson.

Fig. 5. *Cymatella pulverulenta.* *a*, piece of wood bearing several fructifications; *b*, 2 fructifications seen from under (hymenial) side, magnified, collected in Porto Rico by F. L. Stevens, 1358.

Fig. 6. *C. minima.* After Patouillard.

Fig. 7. *Cytidia flocculenta.* Collected in Montana by Mrs. L. A. Fitch.

Fig. 8. *C. salicina.* Showing both young, pezizoid and expanded fructifications, collected in Canada by J. Macoun.

Fig. 9. *C. tremellosa.* Collected in Louisiana by A. B. Langlois, 2620.

BURT—THELEPHORACEAE OF NORTH AMERICA
1. CLADODERRIS DENDRITICA.—2. C. FLORIDANA.—3. SKEPPERIA SPATHULARIA.—4. HYPOLYSSUS MONTAGNEI.—5. CYMATELLA PULVERULENTA.—6. C. MINIMA.—7. CYTIDIA FLOCCULENTA.—8. C. SALICINA.—9. C. TREMELLOSA.

SOME WOOD-DESTROYING FUNGI OF JAVA

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In the summer of 1921, Dr. Carl Hartley sent to me from Buitenzorg a package of specimens of the higher fungi, of species which he had observed to be destructive to timber of Java. My study in the determination of these specimens has shown that some of the species have a taxonomic interest in addition to their economic importance, the latter falling in the field of Dr. Hartley for extended consideration.

The following species were received:—

POLYPORACEAE

Fomes Korthalsii (Lév.) Cooke, as understood by Bresadola, Hedwigia 51: 312. 1912.

Butt rot on living *Castanea argentea*, West Java, *C. Hartley* (in Mo. Bot. Gard. Herb., 59493).

Common on living *Castanea*, Tjiboda, West Java, *C. Hartley* (in Mo. Bot. Gard. Herb., 59491).

Fomes pectinatus (Kl.) Cooke.

Parasitic on *Tabernaemontana sphaerocarpa*, Madjokerto, East Java, *C. Hartley & R. D. Rands* (in Mo. Bot. Gard. Herb., 59510).

Fomes velutinosus Hutchins in Lloyd, Myc. Writ. 4: Syn. Fomes 260. *text f. 599.* 1915.

On dead koerea, West Java, *C. Hartley* (in Mo. Bot. Gard. Herb., 59507).

This species is suggestive of *Polyporus gilvus* in aspect and coloration and presence of setae in the hymenium but has colored spores 5 × 4 μ and the tubes in two strata.

Fomes (Ganoderma) applanatus Fr.

On stump of *Acacia decurrens*, Buitenzorg, Java, *C. Hartley* (in Mo. Bot. Gard. Herb., 59504).

Polystictus elongatus (Berk.) Fr.

Issued July 25, 1924.

On dead *Quercus pseudo-mollucca*, altitude 5000 ft., West Java, *C. Hartley* (in Mo. Bot. Gard. Herb., 59505).

Polystictus nothopus Lév. in Sacc. Syll. Fung. 6: 233. 1888. Plate 2, fig. 1.

Polyporus notopus Léveillé, Ann. Sci. Nat. Bot. III. 2: 194. 1844.

On dead *Vernonia arborea*, altitude 4500 ft., West Java, *C. Hartley* (in Mo. Bot. Gard. Herb., 59515).

This species was described by Léveillé as follows:—

"Pileo duro suborbiculari, subvelutino obsolete zonato, poris inconspicuis rotundis fuscis, stipite dorsali brevi obliquo sursum attenuato pileo concolori.

"—Hab. Java, ad truncos.

"*Polyporus proboscideus* Junghuhn (herb. Lugd. Batav.).

"Chapeau petit, presque ligneux, large de 4 à 6 millimètres, très curieux, parce que le pédicule nâit à peu près à la partie moyenne de la face supérieure du chapeau, et se dirige obliquement en haut et en arrière pour se fixer; la couche de pores regarde, malgré cette disposition, vers la terre."

Judging by the specimens received, the pilei are gregarious, very small, conical, pendant, dorsally attached, either centrally or somewhat obliquely, 4–10 mm. broad, 3–4 mm. thick from point of attachment to the mouth of the pores; the surface cinnamon-buff of Ridgway, sericeous to subvelutinous, obscurely zonate; the margin thin, entire usually, slightly lobed in one instance; context light buff, woody; tubes 150 μ long, mouths cinnamon-buff, angular, about 10 to a mm.; basidia simple, pyriform, $7\frac{1}{2} \times 3\frac{1}{2}$–4 μ; spores hyaline, even, 4×3–$3\frac{1}{2}$ μ; no seta, cystidia, hyphal fascicles, nor gloeocystidia. *Xanthochrous opisthopus* Patouillard, Bull. Mus. Hist. Nat. 29: 336. 1923, from Annam, should be compared with *P. nothopus*.

Polystictus spadiceus (Jungh.) Cooke.

On dead *Altingia excelsa*, West Java, *C. Hartley* (in Mo. Bot. Gard. Herb., 59512).

Poria medulla-panis Pers.

On stump, West Java, *C. Hartley* (in Mo. Bot. Gard. Herb., 59505).

The specimens are broadly resupinate and stratose but infested by a Hyphomycete and sterile.

Poria sp.

On dead *Vernonia arborea*, altitude 4500 ft., West Java, *C. Hartley* (in Mo. Bot. Gard. Herb., 59506).

The fructification is resupinate on a rotten limb, and covering an area 10 cm. long, 2–3½ cm. broad, between warm buff and antimony yellow of Ridgway in dry condition; pores with mouths angular, about 4 to a mm. The hymenium is deteriorated and shows neither basidia nor spores.

Trametes corrugata (Pers.) Bres.

Polystictus Persoonii Cooke.

On living *Hevea brasiliensis*, Buitenzorg, Java, *R. D. Rands, 192* (in Mo. Bot. Gard. Herb., 59497).

HYDNACEAE

Hydnum obrutans Burt, n. sp. Plate 2, fig. 2.

Type: in Mo. Bot. Gard. Herb.

Fructification resupinate, long and widely effused, not separable, white, becoming up to 2½ cm. thick by the older teeth becoming buried and grown together under those of more recent formation, soft and easily sectioned when moistened; teeth white, cylindric, subulate, oblique, nearly parallel with the substratum, free portion 1–2 mm. long, about 3–4 to a mm.; no setae, cystidia, nor gloeocystidia; basidia simple; spores hyaline, even, globose, 4½ μ in diameter, copious.

Fructifications large; fragments fractured on all sides, up to 10 cm. long, 2½ cm. wide, 5 mm.–2½ cm. thick; teeth about 200–250 μ in diameter.

Causing heart rot of living trunks of *Quercus* sp., 4500 ft. altitude, West Java, *C. Hartley*, type (in Mo. Bot. Gard. Herb., 59520).

This species is noteworthy by its parasitic nature, great thickness attained through consolidation together of the buried teeth comparable with that of the tubes of a *Fomes*, white color, and fracturing into chalk-like masses when dry but soft and not truly fleshy nor calcareous when moistened.

THELEPHORACEAE

Stereum obscurans Burt, n. sp. Plate 2, fig. 3.

Type: in Mo. Bot. Gard. Herb.

Pileus coriaceous, rigid, thin, broadly wedge-shaped to dimidiate, sessile, tapering to a point of attachment, the upper surface tawny olive of Ridgway, somewhat radiately rugose, short tomentose, with the tomentum disappearing more or less near the margin in narrow zones and there showing the pallid quaker drab surface of the bared areas, the margin more or less lobed; in structure 800 μ thick, with the intermediate layer composed of densely and longitudinally arranged, slightly colored hyphae, and bordered on the upper side by a broad dark zone which bears the tomentum of the covering; hymenium glabrous, pallid quaker drab, blackening when sections are treated with dilute potassic hydrate; no setae, cystidia, nor gloeocystidia; no spores found.

Pilei 4–5 cm. long, 5–6 cm. broad.

On dead wood, Tjibodas, West Java, *R. D. Rands*, comm. by C. Hartley, type (in Mo. Bot. Gard. Herb., 59518).

The two pilei received have had the marginal portions broken away near the point of attachment but lead me to believe that they were not connected with a reflexed portion nor umbonate-sessile. The hymenium, margin, and some zones of the upper surface of the pileus are tinged with pallid quaker gray of Ridgway, i. e., livid like the hydrogen arsenide flame. In lactic acid mount the sections show their hyphae to be somewhat rough-walled, as though resinous incrusted—especially so the tomentum on surface of pileus, the dark zone bearing the tomentum, and the hymenium; dilute potassic hydrate blackens all the incrusting matter and also the contents of many hyphae. I have observed similar incrusting matter and color changes in no species studied by me heretofore.

Hymenochaete nigricans (Lév.) Pat.

On dead *Altingia excelsa*, altitude 4000 ft., West Java, *C. Hartley* (in Mo. Bot. Gard. Herb., 58683).

Aleurodiscus acerinus (Pers.) v. Höhn. & Litsch.

On living *Theobroma excelsa*, Buitenzorg, *C. Hartley* (in Mo. Bot. Gard. Herb.).

TREMELLACEAE

Heterochaete tenuicula (Lév.) Pat.

On dead *Arikakadoea* sp., altitude 5000 ft., West Java, *C. Hartley* (in Mo. Bot. Gard. Herb., 58684).

Protomerulius javensis Burt, n. sp. Plate 2, fig. 4.

Type: in Mo. Bot. Gard. Herb.

Fructifications resupinate, effused in elongated patches, coriaceous, separable when moist, drying tawny olive of Ridgway, and showing under the microscope an imperfectly porose surface with thin irregular folds and dissepiments somewhat lacerate; pores angular, sinuose, shallow, about 60 μ deep, about 10 to a mm., sometimes elongated laterally and divided by cross partitions into smaller, equal, angular pits or pores; in structure about 400 μ thick, composed of densely interwoven, slightly colored, non-incrusted, thick-walled hyphae 2 μ in diameter; basidia pyriform, longitudinally cruciately septate, 12–18 × 6–7 μ; spores simple, hyaline, even, curved, 15 × 4 μ, but few found.

Fructifications up to 5 cm. long, 2–3 cm. wide, about ½ mm. thick.

On dead, rotten limbs of *Castanea argentea*, 5000 ft. altitude, West Java, *C. Hartley*, type (in Mo. Bot. Gard. Herb., 59516).

Other species of *Protomerulius* are *P. brasiliensis* A. Möller and *P. Farlowii* Burt—the first from Brazil and the second from New Hampshire. The occurrence of these 3 species at such great distances apart is remarkable.

A mycelium causing a locally destructive root-rot of teak was also received, but I could detect no fructifications by which it might be identified.

On roots of teak, *Tectonia grandis*, East Java, *C. Hartley* (in Mo. Bot. Gard. Herb., 59521).

Explanation of Plate

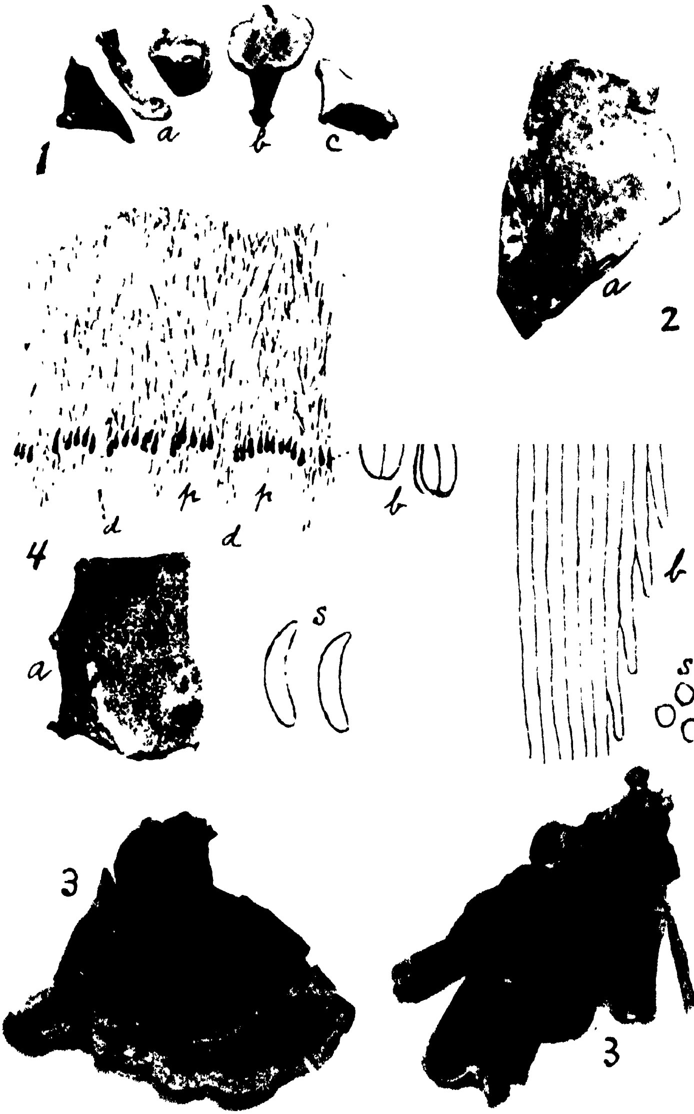
PLATE 2

Fig. 1. *Polystictus nothopus* from specimens collected by C. Hartley, × 2. Three fructifications showing upper surface, *a*; *b*, another fructification showing under side and pores; *c*, a fructification divided longitudinally to show the interior and depth of the tubes.

Fig. 2. *Hydnum obrutans.* Portion of the type specimen showing the teeth, × 2, *a*; diagram of part of vertical longitudinal section, × 10, showing free portions of the teeth borne on stratified buried teeth, *b*; three spores, *s*, × 750.

Fig. 3. *Stereum obscurans.* Two pilei of type specimen showing upper surface, natural size.

Fig. 4. *Protomerulius javensis.* Part of type specimen showing hymenial folds and pits, × 2, *a*; vertical section of fructification showing hymenial folds or dissepiments, *d*, and pits or pores, *p*, × 90. The basidia are the 2–11 small, dark, clavate organs near the bottom of each pit. Two basidia, × 750, *b*; two spores, × 750, *s*.



BURT—WOOD-DESTROYING FUNGI OF JAVA

1. POLYSTICTUS NOTHOPUS.—2. HYDNUM OBRUTANS.
—3. STEREUM OBSCURANS.—4. PROTOMERULIUS JAVENSIS

STUDIES IN THE PHYSIOLOGY OF THE FUNGI.

XVII. The Growth of Certain Wood-Destroying Fungi in Relation to the H-Ion Concentration of the Media[1]

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Introduction

That wood-destroying fungi grow more favorably upon substances acid in reaction has been appreciated by many students who have given attention to the biology of these organisms. Investigations in this field have received a marked impetus from the recently perfected methods for determining the hydrogen-ion concentration of solutions. Webb ('19, '21) has given many interesting data upon the effect of hydrogen-ion concentration upon spore germination, while other investigators from this laboratory and those from other laboratories have worked upon the relationships of hydrogen-ion concentration of the medium to the mycelial growth of some of the *Agaricales*.

However, since this order of the fungi contains such a large number of wood-destroying species, and because increased knowledge of their biology leads to better methods of combating their spread and ravages, through improved methods of preservation from a practical as well as from an academic standpoint, it seems advisable to make a more detailed study of the following questions: What hydrogen-ion concentration will inhibit mycelial growth of these fungi? How do these fungi react to hydrogen-ion concentration in different types of media and at different temperatures? Is growth always inhibited by an alkaline solu-

[1] An investigation carried out at the Missouri Botanical Garden in the Graduate Laboratory of the Henry Shaw School of Botany of Washington University, and submitted as a thesis in partial fulfillment of the requirements for the degree of doctor of philosophy in the Henry Shaw School of Botany of Washington University.

tion? What are the changes in the hydrogen-ion concentration of the substratum caused by mycelial growth? The present paper attempts to answer these questions as completely as the available time would allow.

HISTORICAL REVIEW

Tubeuf ('03) found that NaH_2PO_4 in solution supported mycelial growth of *Merulius lacrymans*, while Na_2HPO_4 and Na_3PO_4 did not. Similar results were obtained with the acid and alkaline phosphate salts of potassium and ammonium. As the monobasic salts are acid and the dibasic and tribasic salts are alkaline, it is concluded that growth is inhibited in alkaline solutions but not in acid solutions.

Rumbold ('08) was the first to determine the inability of the *Agaricales* as a group to grow upon alkaline media. The acidity of separate portions of 5.0 per cent gelatine and 0.5 per cent malt extract solution was so adjusted that solution 1 reacted red to litmus paper; solution 2, red-violet; solution 3, violet; solution 4, blue-violet; and solution 5, blue. Fifteen species of *Agaricales* including *Schizophyllum commune*,[1] *Lenzites sepiaria*, *Pholiota adiposa*, and *Armillaria mellea* grew extensively in solutions 1 and 2, somewhat less in solution 3, still less in solution 4, and not at all in solution 5. Solutions 1, 2, and 3 were considered by her to be acid; solution 4, neutral or very slightly alkaline; and solution 5, distinctly alkaline. It is known that litmus gives a positive red color in solutions which have an active acidity of P_H 5.0 or greater, a red-violet color when the P_H is approximately 6.0, and a violet color close to P_H 7.0. A blue color is obtained in all solutions with an active alkalinity of P_H 8.0 or greater. From this it is concluded that, while the organisms used by Miss Rumbold did grow to some extent in a neutral or slightly alkaline solution the amount of growth was less than that obtained in solutions with initial acidities of approximately P_H 5.0 and 6.0. Furthermore, growth was entirely inhibited in solutions which were as alkaline as P_H 8.0.

These same fungi grew rapidly in an acid medium consisting of: 100 cc. Knop's solution, 3 gms. agar, and 5 gms. grape sugar.

[1] The recent and prevalent names have been used for all fungi under discussion.

Good growth resulted when 0.25 per cent of sulphuric acid was added to this solution. When the same medium was made alkaline with sodium carbonate, no growth was obtained.

The acidity of the medium has been shown by Falck ('12) to be a conditioning factor for spore germination and for mycelial growth of species of *Merulius*. Furthermore, he has observed that growth and development of *Merulius* is more rapid upon wood previously infected by *Coniophora cerebella* than upon sound wood. Since mycelial growth of *Coniophora cerebella* makes the substratum decidedly acid, it is assumed that species of *Merulius* are partial to acid media.

Wehmer ('14) indicated that *Merulius lacrymans* increased the active acidity of the medium upon which it grew. One gm. of sound pine wood pulverized and boiled in 30 cc. of water and titrated against 0.1 *N* NaOH[1] required 0.9–1.2 cc. to neutralize the solution. Decayed wood similarly treated required 4.9–8.0 cc. for neutralization.

Lenzites sepiaria, *Fomes pinicola*, *Polystictus versicolor*, and *Polyporus lucidus*, according to Zeller ('16), did not grow upon slightly alkaline Thaxter's glucose-potato-hard agar, while a readjustment to slight acidity resulted in good growth. This indicates for all of these species a marked intolerance to alkaline media.

The hydrogen-ion concentration necessary to inhibit the growth of *Lenzites sepiaria*, *Fomes roseus*, *Coniophora cerebella*, and *Merulius lacrymans* upon synthetic and malt extract media was determined by Meacham ('18). While the 4 species show considerable fluctuation, they respond in much the same way to active acidity, showing maximum growth at approximately P_H 3.0. A composite curve indicates good growth with increasing acidity until P_H 3.0–2.6 is reached. There is a distinct critical zone between P_H 2.6 and 1.9 where growth decreases rapidly, followed by total inhibition at P_H 1.7. In general, these figures indicate a marked tolerance to high acidity.

Schmitz ('19) studied the hydrogen-ion concentration conducive to optimum growth for *Fomes pinicola*, *Lenzites sepiaria*,

[1] It is assumed that this solution was NaOH, since Wehmer indicated it as a 1/10 N. N. solution.

and *Polystictus versicolor* upon a carrot extract-glucose-agar medium. His results, expressed in the diametric growth in centimeters of the fungus colonies, show that for the first 2 species there is little difference in growth from + 5 to + 24.5, Fuller's scale, while at + 2.5 there is a marked retardation. *Polystictus versicolor*, on the other hand, is more sensitive to changes in acidity, showing maximum growth at + 9.75 and a steady decrease as the acidity increases. He concluded that slight variations in the acidity of the substratum did not affect the growth of *Fomes pinicola* and *Lenzites sepiaria*, while they might influence that of *Polystictus versicolor*.

Employing Czapek's, Dunham's, Reed's, and Richards' solutions, sap from *Acer saccharinum*, and a pine decoction, a determination of the influence of the hydrogen-ion concentration, among other things, upon the growth of wood-destroying fungi was attempted by Zeller, Schmitz, and Duggar ('19). Although it is impossible to make any conclusive statements, within the range of the experiments the hydrogen-ion concentration was not a limiting factor in growth. The control solutions showed that in only one series, the Czapek's solution with K_3PO_4, was the reaction definitely alkaline with an initial P_H of 8.6 at the time of inoculation. Upon this solution *Polystictus versicolor* grew slowly, changing the reaction to P_H 4.8 within 30 days. *Daedalea confragosa* failed to grow upon this same solution, the final reaction being P_H 8.4. These results suggest that all of the wood-destroying fungi do not react alike toward slightly alkaline solutions.

Webb ('19) studied spore germination of a number of fungi in relation to the hydrogen-ion concentration of a M/5 mannite medium. Spores of *Lenzites sepiaria* did not germinate readily when the reaction was acid. Increasing acidity from P_H 7.0 to 3.1–2.8 favorably affected germination of the spores of this and of other species of fungi.

A second paper by Webb ('21) showed that increasing acidity of mannite, peptone, and Czapek's solutions, sugar beet decoction, "water H_3PO_4 and NaOH," and "water HCl or KOH" from neutrality to approximately P_H 3.0 to 4.0 favorably influenced spore germination of *Lenzites sepiaria* and of other

fungi. Beet decoction gave the best percentage and range of germination and "water H_3PO_4 and NaOH" the poorest. He observed that in equal concentrations the OH ions are more toxic to the spores of the fungi studied than are the H ions. His results indicate that the range and percentage of germination, as influenced by the hydrogen-ion concentration, depend upon both the organism and the medium, and that the direction and magnitude of the change in the reaction of the medium due to spore germination depend upon the fungi, the medium, and the initial reaction of the solution.

Methods

Organisms.—In the selection of organisms, 3 things were considered: (1) the use of as many representative genera as possible, (2) the use of species found commonly both on deciduous woods and on coniferous woods, and (3) the use of forms which grow well upon artificial media. With these considerations in mind, the following 8 species were selected: *Polyporus adustus* (Willd.) Fr., *Polystictus versicolor* (L.) Fr., *Pleurotus ostreatus* Jacq., *Schizophyllum commune* Fr., *Pholiota adiposa* Fr., *Lenzites sepiaria* (Wulf.) Fr., *Armillaria mellea* (Vahl) Quel., and *Daedalea confragosa* (Bolt.) Fr.

These species are common wherever their respective hosts are found. Preliminary work has shown them to make more rapid growth in artificial culture than many other common fungi. Weir ('14) found that *Armillaria mellea* is common both on deciduous and on coniferous woods; that *Lenzites sepiaria* is confined almost entirely to coniferous species, whereas *Polystictus versicolor* and *Polyporus adustus* are usually upon deciduous species but are found occasionally upon coniferous hosts. *Pholiota adiposa* is found on *Abies grandis* as well as on some deciduous trees. *Schizophyllum commune*, common on deciduous woods, according to Rhoades ('21), occurs occasionally upon coniferous hosts. *Daedalea confragosa* and *Pleurotus ostreatus* are regarded as saprophytic upon deciduous woods.

Pure culture methods.—Pure cultures were made by employing either the tissue-culture method described by Duggar ('05) or the spore method used by Zeller ('16). These methods have

been adequately described in the papers referred to and in later papers from this laboratory, so they require no discussion at this point. The spore method was used when it was impossible to secure sterile tissue, as from particularly thin sporophores. After the mycelium had made considerable growth upon potato agar, the cultures were transferred to large bottles of sterile bean stems and pods, to sterile decayed wood, and to sterile decayed wood mixed with decayed leaves. Growth was more rapid in the bean stem and pod cultures, but in all cases it was abundant enough to constitute satisfactory stock cultures.

Inoculum was prepared according to the method of Zeller, Schmitz, and Duggar ('19) by growing bits of mycelium from these stock cultures upon plates of sterile agar made according to the following formula: 1000 cc. potato water from 240 gms. of potatoes boiled for 1 hour, 20 gms. cane sugar, 10 gms. KNO_3, 5 gms. KH_2PO_4, and 20 gms.agar. After a growth period of 10 days to 2 weeks, these plates were cut into pieces 8–10 mm. square. Each culture flask received 1 of these squares of inoculum.

Culture solutions.—The culture media can be divided into two classes, based on the absence or presence of celluloses. The first class consists of 3 types, as described later, namely: (1) a modification of Richards' E solution, (2) a peptone-nutrient solution with sugar, and (3) a peptone-nutrient solution without sugar.

The modified Richards' E solution contained: $MgSO_4$, 0.5 gm.; KNO_3, 5 gms.; NH_4NO_3, 10 gms.; trace $FeSO_4$; varying amounts of H_3PO_4, KH_2PO_4, and K_2HPO_4 to give a total of 10.4 gms. of phosphate; and doubly distilled water, 1000 cc. The 3 forms of the phosphate were used in varying proportions to obtain a range of reaction from P_H 2.5 to 8.0 at intervals of 0.5. The large percentage of phosphates and the reduced amount of sugar produced a heavily buffered solution which held, as nearly as possible, the initial P_H throughout the entire incubation period. The amount of $MgSO_4$ was reduced because in the presence of phosphates it produces a precipitate in an alkaline solution. Although all precautions were taken in making the media, slight differences in P_H were evident in each series, requiring some slight variation in the proportion of the phosphate buffers

employed. Table I indicates the method employed in making the solutions.

The nutrient solution, containing all of the nutrients except the phosphates, comprised 28 cc. of the 35 cc. of each culture, or 80 per cent. Consequently all salts and sugar were weighed out on the basis of 1000 cc. of culture solution but made up to only 800 cc. with doubly distilled water. Twenty-eight cc. of this solution were added to each flask. The addition of 7 cc. of phosphate solutions to each culture resulted in bringing all nutrients to the desired concentrations. The KH_2PO_4 was added to the flasks before sterilization; the K_2HPO_4 and H_3PO_4 were autoclaved separately and added aseptically. Sterilization consisted in autoclaving for 15 minutes at 12–15 pounds pressure. This procedure eliminated, as far as possible, any alterations in the acidity of the solutions during autoclaving. The series P_H 8.0 was obtained by adding, before sterilization, 0.5 gm. of $CaCO_3$ to flasks containing 7 cc. of K_2HPO_4. The reaction of this solution varied from P_H 7.8 to 8.2. All hydrogen-ion determinations were made according to the colorimetric method of Clark and Lubs ('17) and Clark ('20).

TABLE I

THE COMPOSITION OF THE MODIFIED RICHARDS' E SOLUTION ADJUSTED TO A RANGE OF P_H FROM 3.0 TO 8.0 AT INTERVALS OF 0.5

Initial P_H	No. cc. M/3 H_3PO_4	No. cc. M/3 KH_2PO_4	No. cc. M/3 K_2HPO_4	No. cc. nutrient solution	Total no. cc.
3.0	1.2	5.8		28	35
3.5	0.5	6.5		28	35
3.9	0.1	6.9		28	35
4.4		7.0		28	35
5.0		6.8	0.2	28	35
5.5		6.3	0.7	28	35
6.0		5.0	2.0	28	35
6.5		3.5	3.5	28	35
7.0		1.5	5.5	28	35
7.6			7.0	28	35
7.8–8 2	0.5 gm. $CaCO_3$ added		7.0	28	35

The peptone-nutrient solution with sugar contained: bactopeptone, 25 gms.; cane sugar, 30 gms.; $MgSO_4$, 0.5 gm.; trace of $FeSO_4$, varying amounts of H_3PO_4, KH_2PO_4, and K_2HPO_4 to

give a total of 9.65 gms. of phosphates; and doubly distilled water to make 1000 cc. of solution. This peptone-nutrient solution throughout this work will be referred to as the peptone solution. This solution without sugar gave the third type of media used in this first class of solutions. As with the Richards' solution, slight variations in the hydrogen-ion concentrations were encountered, but these were all eliminated by slight modifications of the phosphate content, indicated in table II.

TABLE II

THE COMPOSITION OF THE PEPTONE-NUTRIENT SOLUTION ADJUSTED TO A RANGE OF P_H FROM 2.0 TO 8.5 AT INTERVALS OF 0.5

Initial P_H	No. cc. M/3 H_3PO_4	No. cc. M/3 KH_2PO_4	No. cc. M/3 K_2HPO_4	No. cc. nutrient solution	Total no. cc.
2.0	7.0	1 cc. conc. H_3PO_4		28	35
2.5	7.0	0.1 cc. conc. H_3PO_4		28	35
3 0	7.0			28	35
3 5	5.0	2.0		28	35
3.9	3.0	4 0		28	35
4.5	2.0	5.0		28	35
5 0	1.0	6.0		28	35
5.6		7.0		28	35
6.0		6.0	1.0	28	35
6.5		4.5	2.5	28	35
7.0		2 0	5 0	28	35
7.4			7 0	28	35
7.8-8.2	0 5 gm. $CaCO_3$		7.0	28	35
8.5-8.7	1.5 gm. $CaCO_3$ 0.2 cc. conc. KOH		7.0	28	35

The nutrient solution was made up and added to the culture flasks in the same manner as in the Richards' solution. Here, too, the H_3PO_4 and K_2HPO_4 were added aseptically.

The second group of nutrient solutions, those containing celluloses as the only or chief source of carbon are: (1) a modified Richards' E solution with a wood cellulose suspension substituted for the cane sugar; (2) a 0.5 per cent peptone-nutrient solution to which is added 20 gms. of filter-paper in strips for each liter of medium; and (3) the Richards' solution modified as in (1) with the addition of 20 gms. of agar.

The celluloses were prepared from longleaf pine, white oak, sugar maple, and poplar woods. Two-hundred-gm. amounts of each wood cut into small chips were treated for one month at

2° C. in a mixture of 520 cc. of KNO_3 of 1.1 specific gravity and 30 gms. of $KClO_3$ (Zeller, Schmitz and Duggar, '19). After washing and precipitating in Schweitzer's reagent, according to McBeth ('16), an abundance of flocculent cellulose was obtained. This was washed repeatedly in distilled water until free from copper. The washing process was hastened by centrifuging and decanting, the necessarily long periods of time required in the usual settling method being avoided.

TABLE III

THE COMPOSITION OF THE MODIFIED RICHARDS' E SOLUTION CONTAINING CELLULOSE ADJUSTED TO A RANGE OF P_H FROM 3.0 TO 6.0 AT INTERVALS OF 1.0

Initial P_H	No. cc. M/3 H_3PO_4	No. cc. M/3 KH_2PO_4	No. cc. M/3 K_2HPO_4	No. cc. nutrient solution	No. cc. cellulose solution	No. cc. total solution
3.0	1 2	5 8		14	14	35
4.0	0 1	6.9		14	14	35
5 0		6.8	0.2	14	14	35
6.0		5 0	2 0	14	14	35

The Richards' solution with cellulose was adjusted to the desired P_H according to table III. As in the previous cases this table required some slight adjustment for each series. The phosphates constitute 20 per cent of the total volume; the cellulose solutions, 40 per cent; and the nutrient salts, 40 per cent. Therefore all salts were weighed on the basis of 100 per cent, or 1000 cc. of solution, and dissolved in enough doubly distilled water to give a total of 400 cc.—40 per cent of the total amount. Fourteen-cc. amounts of this solution were added to each flask. The proper balance was obtained by the addition of 7 cc. of phosphate solutions and 14 cc. of the cellulose suspension to each flask containing this concentrated nutrient salt solution. The KH_2PO_4 was the only phosphate added before sterilization.

The peptone-filter-paper solution was adjusted to the desired initial P_H according to table II. The reduction in the amount of peptone did not change the amount of phosphates required to obtain the initial P_H. The strips of filter-paper were added in equal amounts to each flask. On the basis of 20 gms. of paper per liter of solution, each culture flask received approximately 0.7 gm. of paper.

In the agar series each 1000 cc. of medium contained 500 cc. of the cellulose suspension, 500 cc. of the nutrient salt solution, and 20 gms. of agar. The P_H was adjusted by the addition of M/3 solutions of H_3PO_4 and KOH. To 150-cc. amounts of the warm agar mixture were added:

Series I, 5.0 cc. H_3PO_4, giving approximately P_H 2.8.
Series II, no addition, giving approximately P_H 4.0.
Series III, 2.5 cc. KOH, giving approximately P_H 4.6.
Series IV, 3.5 cc. KOH, giving approximately P_H 5.0.
Series V, 5.0 cc. KOH, giving approximately P_H 6.0.

The sterile acid and alkali were added aseptically. After thoroughly mixing to assure uniform distribution, the solutions were poured into sterile plates, cooled, and inoculated.

Glassware.—All the glassware was scrubbed with cleaning powder, cleaned in a strong cleaning solution recommended by Duggar ('09, page 13), rinsed in tap water, rinsed in distilled water, and drained dry. Proper precautions were taken to protect such cleaned glass from dust. Pipettes or other glassware for use under sterile conditions were dry-sterilized for at least 1 hour at 150–170° C.

Methods and examination of cultures.—Using all precautions against contamination, triplicate cultures were made in 120-cc. Erhlenmeyer flasks, each one containing 35 cc. of solution. With the exception of the nutrient-agar-cellulose series, which were incubated at room temperature, and of the cellulose and peptone series without sugar, which were incubated only at 25° C., all cultures were incubated for 30 days at 15° C., 25° C., and 35° C. The lowest temperature was maintained approximately between 14° C. and 18° C. in a cellar, while the other 2 were maintained accurately by means of thermostats in incubators.

In all cases where possible, examination was made upon the final P_H of the solution and upon the dry weight of the fungus. This weight was obtained by drying the green mat upon previously dried and weighed filter-papers for 2 days at 100–105° C., and by weighing the combined mat and paper. The difference between the weight of the paper and that of the mat and paper is the weight of the mat alone. The triplicate figures obtained were averaged and given as one reading.

All agar-plate cultures were examined every other day for evidence of growth and for clear zones in the agar, indicating utilization of the cellulose. The diametric growth both of the mycelial colony and of the clear zone was recorded in millimeters. Because of the impossibility of separating the mat from the cellulose and filter-paper, the weights of the fungus in solutions

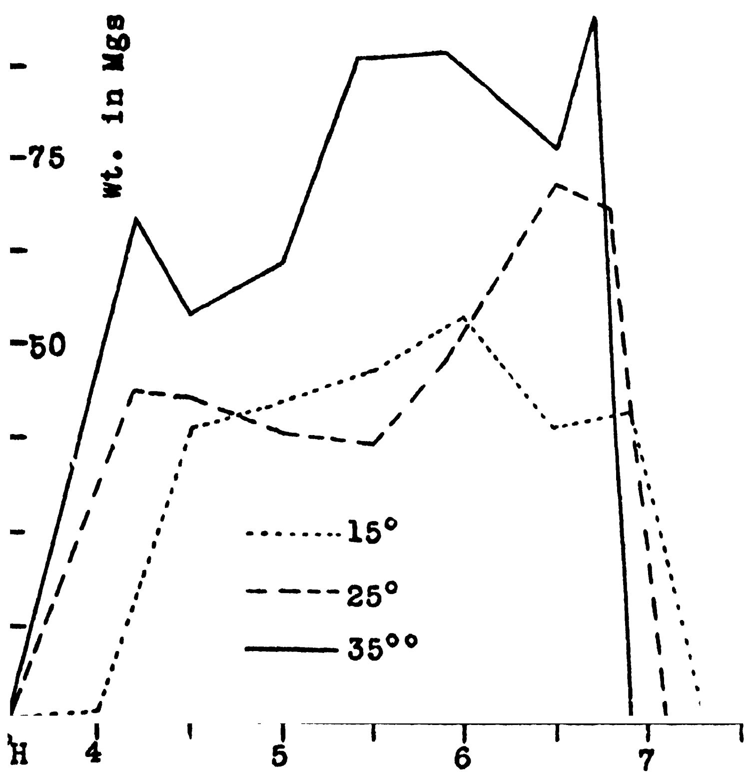

Fig. 1. *Lenzites sepiaria* in Richards' solution.

containing these materials were not determined. In these cases the amount of growth and the hydrolysis of the filter-paper were compared by definite scales. These will be discussed in the experimental data.

As far as possible the work has been reported in the form of curves. The dry weights in mgs. are plotted as the ordinates, and the initial P_H as the abscissae. Unless otherwise stated,

each figure represents a single fungus. In order to keep the size of the curves within reasonable limits, the ordinates have been given different unit values, in some cases a unit being 25 mgs., in some, 50 mgs., and in 2 cases, 100 mgs.

Experimental Data

The experimental data will be presented in accordance with the following grouping of the culture media: (1) Richards' solution and peptone solution with sugar, (2) peptone solution without sugar, (3) peptone solution with filter-paper, (4) Richards' solution with cellulose, and (5) Richards' solution with cellulose and agar.

The effects of changes in the hydrogen-ion concentration of the media and the interrelation between this factor and growth

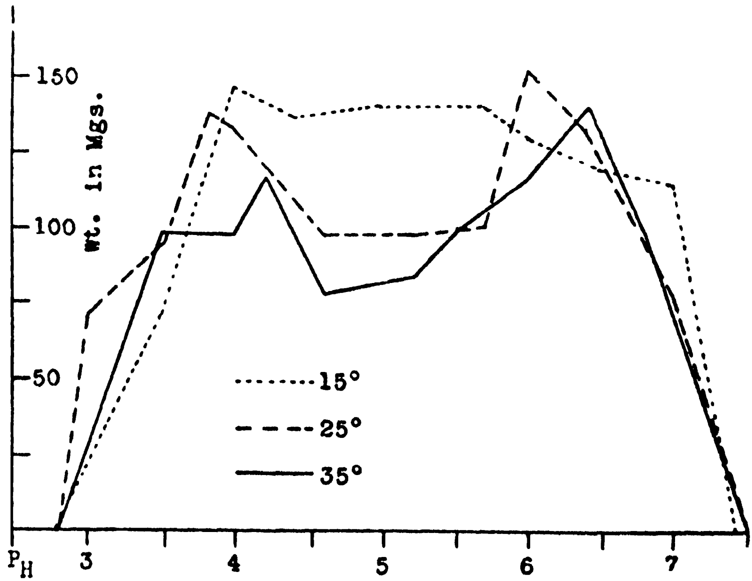

Fig. 2. *Lenzites sepiaria* in peptone-nutrient solution.

of *Lenzites sepiaria* in the peptone solutions and Richards' solution are brought out in table IV and figs. 1–2. In the Richards' solution (fig. 1) the fungus grows slowly. At 15° C. growth is limited by P_H 3.5 and 7.3 with only a trace[1] at P_H 4.0. It is evi-

[1] Where growth is visible to the eye but too little to be weighed accurately it is called a trace.

dent that the actual acid limit for appreciable growth lies closer to P_H 4.0 than to 3.5. The best growth is obtained at P_H 6.0 with a mat weighing 54 mgs. At 25° C., although growth is better than at 15° C., it has about the same range of P_H while the optimum lies at 6.5 with 72 mgs. of felt. At 35° C. the fungus grows better than at either of the other temperatures and produces a mat weighing 94 mgs. at P_H 6.7. At this temperature, however, there is no indication of increased tolerance to either alkalinity or acidity. In fact, P_H 6.8 does not support growth as it does at 15° C. and 25° C., while the acid limit remains the same as at the lower temperatures.

TABLE IV

THE GROWTH OF LENZITES SEPIARIA AND THE CHANGES IN THE ACTIVE ACIDITY IN BOTH THE RICHARDS' AND THE PEPTONE SOLUTIONS AT DIFFERENT INITIAL P_H AND TEMPERATURES

	15° C.			25° C.			35° C.		
	P_H		Wt. of mat in mgs.	P_H		Wt. of mat in mgs.	P_H		Wt. of mat in mgs.
	Initial	Final		Initial	Final		Initial	Final	
Richards' sol.	3.5	3.5	0	3.5	3.5	0	3.5	3.5	0
	4.0	3.7	trace	4.2	3.7	44	4.2	3.5	67
	4.5	3.7	30	4.5	3.6	43	4.5	3.8	54
	5.0	3.6	42	5.0	3.6	38	5.0	3.7	61
	5.5	4.4	47	5.5	3.6	37	5.4	3.9	88
	6.0	5.0	54	5.9	4.7	48	5.9	3.9	89
	6.5	5.8	39	6.5	5.0	72	6.5	3.8	76
	6.9	6.4	41	6.8	4.9	68	6.7	7.4	94
	7.3	7.3	0	7.1	7.1	0	6.9	6.9	0
Peptone sol.	2.8	2.8	0	2.8	2.8	0	2.8	2.8	0
	3.5	3.4	71	3.5	3.1	95	3.5	3.2	98
	4.0	3.5	146	3.8	3.1	139	4.0	3.3	98
	4.4	3.3	137	4.6	3.4	99	4.6	3.8	78
	5.0	3.3	141	5.2	3.4	99	5.2	3.6	85
	5.7	3.3	141	5.7	3.5	101	5.5	3.3	100
	6.0	3.4	130	6.0	3.0	153	6.0	3.8	117
	6.5	3.8	120	6.4	3.4	133	6.4	3.6	141
	7.0	4.5	115	7.0	4.0	76	6.8	3.8	99
	7.4	7.4	0	7.6	7.6	0	7.6	7.6	0

In the peptone solution (fig. 2) this fungus grows much better than in the Richards' solution. Growth at 15° C. is as good, if not slightly better, than that at either 25° C. or 35° C. The inhibiting reactions are P_H 2.8 and 7.4. Maximum growth is obtained between P_H 4.0 and 5.7. Although growth is less pronounced at 25° C. than at 15° C., the acid limit is not materially altered. A

secondary maximum is shown at P_H 3.8 with 138 mgs. This is followed by a marked decrease between P_H 4.0 and 5.5, rising again to the maximum point, P_H 6.0 with 153 mgs. The P_H limits at 35° C. correspond rather closely to those at 15° C. Here, too, there is a secondary maximum at P_H 4.2, and a maximum at P_H 6.4 with 141 mgs. As in the Richards' solution, the optimum hydrogen-ion concentration lies between P_H 5.5 and 7.0.

In all cases growth tends to increase the active acidity of the nutrient solutions (table IV). This is more marked in the peptone

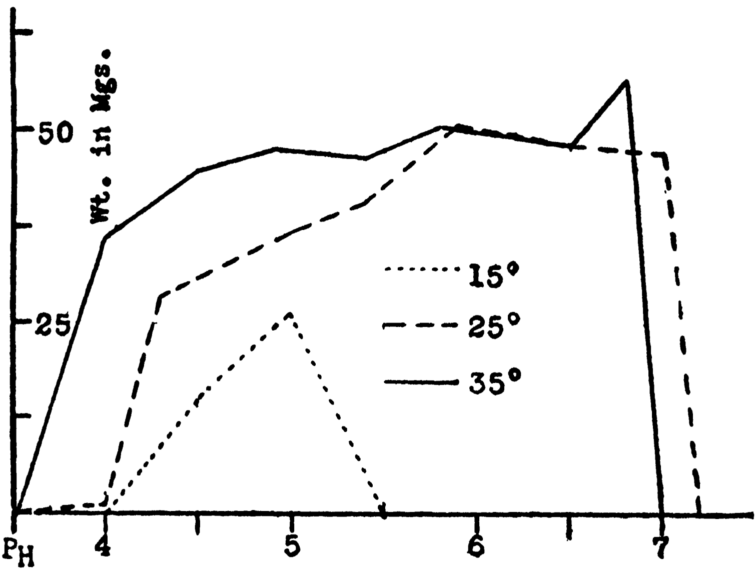

Fig. 3. *Daedalea confragosa* in Richards' solution.

solution where the final P_H range from 3.3 to 4.5 with a mean[1] of 3.5 at 15° C., 3.0 to 4.0 with a mean of 3.3 at 25° C., and 3.2 to 3.8 with a mean of 3.5 at 35° C. In the Richards' solution the final values range from P_H 3.7 to 6.4 with a mean of 4.6 at 15° C., 3.7 to 4.9 with a mean of 4.2 at 25° C., and 3.5 to 4.4 with a mean of 3.9 at 35° C.

The peptone medium supports growth through a slightly wider acid range than does the Richards' solution. However,

[1] The mean is obtained from the final P_H in those solutions supporting mycelial growth.

in neither case does the fungus grow in a slightly alkaline solution. Although 35° C. is the optimum temperature for growth in the Richards' solution, in the peptone it shows no advantage over the other two. The optima P_H ranges do not vary materially in either case except for the secondary maxima found in the peptone solution at 15° C. and 35° C. In both cases the active acidity of the medium is slightly increased. In the majority of instances the final P_H is close to the hydrogen-ion concentration which inhibits the mycelial growth of this fungus.

In the Richards' solution at 15° C. the mycelium of *Daedalea confragosa* (table v, fig. 3) shows a very narrow range of growth, between P_H 4.0 and 5.5. At 25° C. and 35° C. the P_H limit on the acid side is 3.5, but on the alkaline side it is 7.0 at 35° C. and 7.2 for 25° C. The optimum range for the two higher temperatures lies between P_H 5.5 and 7.0, with a slow decrease in growth as the solutions become more acid, and a sharp drop to 0 after passing the neutral point.

TABLE V

THE GROWTH OF DAEDALEA CONFRAGOSA AND THE CHANGES IN THE ACTIVE ACIDITY UPON BOTH THE RICHARDS' AND PEPTONE SOLUTIONS AT DIFFERENT INITIAL P_H AND TEMPERATURES

	15° C.			25° C.			35° C.		
	P_H		Wt. of mat in mgs.	P_H		Wt. of mat in mgs.	P_H		Wt. of mat in mgs.
	Initial	Final		Initial	Final		Initial	Final	
Richards' sol.				3.5	3.5	0	3.5	3.5	0
	4.0	3.9	0	4.0	3.6	trace	4.0	3.7	36
	4.5	3.9	15	4.3	3.5	28	4.5	3.6	45
	5.0	4.7	27	5.0	3.5	37	4.9	3.9	48
	5.5	5.5	0	5.4	3.8	41	5.4	3.8	44
				5.9	4.4	51	5.8	5.1	51
				6.5	5.9	48	6.5	5.7	48
				7.1	6.3	47	6.8	6.3	57
				7.2	7.2	0	7.0	7.0	0
Peptone sol.				2.8	2.8	0	2.8	2.8	0
	3.3	3.3	0	3.5	6.5	332	3.6	6.5	210
	4.0	4.7	166	4.0	6.4	267	4.0	6.6	188
	4.5	5.7	197	4.3	6.7	213	4.2	5.7	128
	4.9	6.0	198	5.0	6.6	212	5.0	6.3	147
	5.5	5.5	150	5.5	6.3	330	5.4	5.5	99
	6.0	5.8	138	6.0	6.3	333	5.9	6.2	110
	6.6	6.2	142	6.4	6.6	197	6.5	5.6	82
	7.0	5.9	100	7.0	6.9	71	7.0	7.1	67
	7.6	7.6	0	7.5	7.5	0	7.5	7.5	0

In the peptone solution (fig. 4) the fungus grows best at 25° C. with maxima of 332 mgs. at P_H 3.5 and of 330 and 333 mgs.

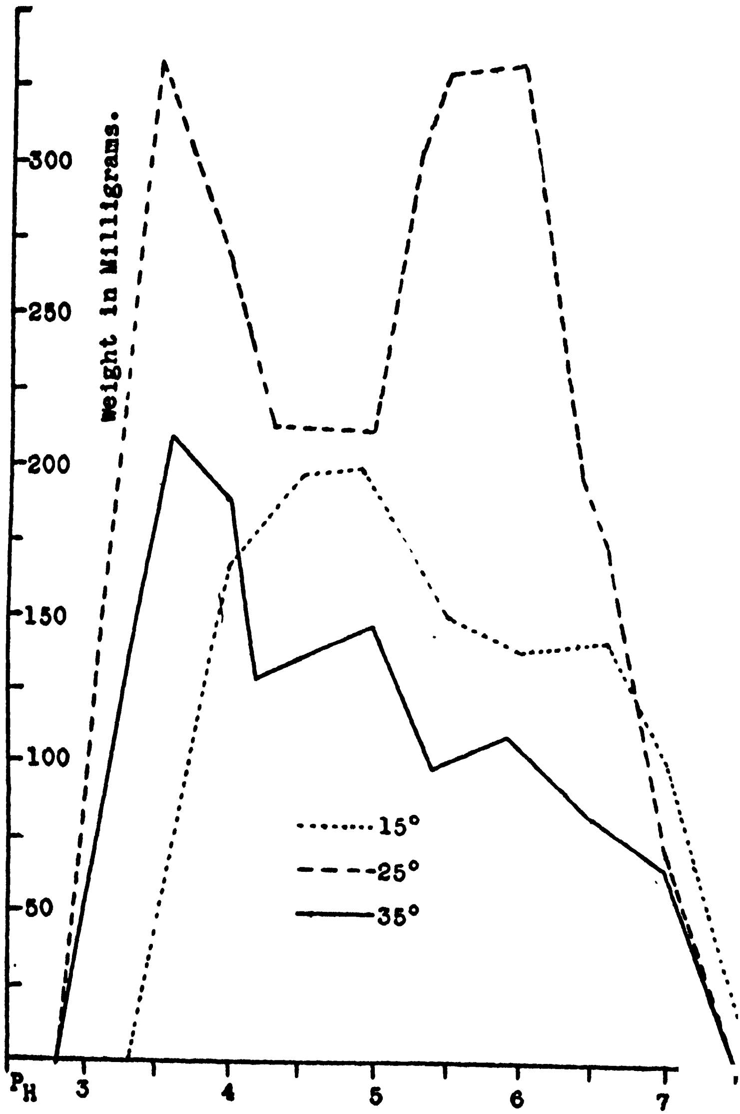

Fig. 4. *Daedalea confragosa* in peptone-nutrient solution.

at P_H 5.5 and 6.0. These two are separated by a sharp drop at P_H 4.0–5.0. The facts that growth is inhibited at P_H 2.8 at

25° C. and 35° C. and at 3.3 at 15° C., and that the optimum range at 15° C. is P_H 4.5–4.9 and 3.6–4.0 at 35° C. indicate less tolerance to acid at the lowest temperature. The growth curve at 25° C. is the only one to show a secondary maximum toward the neutral point.

In the Richards' solution, in general, the active acidity is increased by growth. The final P_H range from 3.5 to 6.5 at 35° C. with a mean of 5.0, and from 3.6 to 6.3 at 25° C. with a mean

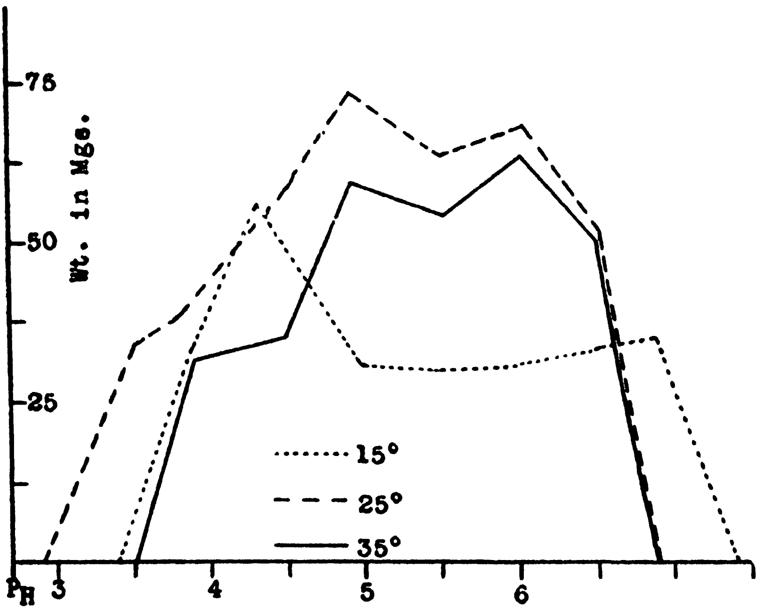

Fig. 5. *Armillaria mellea* in Richards' solution.

of 4.9. On the other hand, in the peptone solution the active acidity is markedly decreased toward neutrality, the final values at 15° C. being P_H 4.7 to 6.9 with a mean of 5.9; at 25° C., 6.2–6.9 with a mean of 6.5; and at 35° C., 5.6 to 7.1, with a mean of 6.3. Only in the initial P_H range, 6.0–7.0 at 15° C., and P_H 7.0 at 25° C. and 6.5 at 35° C. is the acidity of this solution increased.

While this fungus grows a little better at 35° C. than at 25° C. in the Richards' solution, it grows much better at the lower temperature in the peptone solution. In fact, 35° C. is the least favorable of the 3 temperatures in this latter solution, while 15° C. is evidently the poorest in the former. In the peptone, although

the optimum P_H varies with the temperature, it lies in a more acid range than in the Richards' solution. In the first medium the fungus decreases the active acidity close to the neutral point, while in the second, it slightly increases throughout the entire growth-range.

Armillaria mellea in the Richards' solution grows only in cultures in which the reaction is acid, as shown in table VI, fig. 5. Growth at 25° C. and 35° C. is more pronounced than at 15° C. and, of these two, 25° C. is the more favorable. At this temperature growth is inhibited by P_H 2.9 and 6.9, a wider limit on the acid side and a narrower limit on the alkaline side than at 15° C., where growth is inhibited by P_H 3.4 and 7.4. The curve at 35° C. resembles that at 25° C. but the amount of growth is less and the P_H limits are narrower, being 3.4 and 6.9. The optimum in this high temperature is at P_H 6.0 with a mat weighing 63 mgs.,

TABLE VI

THE GROWTH OF ARMILLARIA MELLEA AND THE CHANGES IN THE ACTIVE ACIDITY UPON BOTH THE RICHARDS' AND PEPTONE SOLUTIONS AT DIFFERENT INITIAL P_H AND TEMPERATURES

	15° C.			25° C.			35° C.		
	P_H		Wt. of mat in mgs.	P_H		Wt. of mat in mgs.	P_H		Wt. of mat in mgs.
	Initial	Final		Initial	Final		Initial	Final	
Richards' sol.				2.9	2.9	0			
	3.4	3.4	0	3.5	3.3	34	3.4	3.4	0
	3.9	3.8	34	3.8	3.6	38	3.9	3.7	32
	4.3	3.5	56	4.5	3.9	59	4.5	3.8	35
	5.0	4.5	31	4.9	4.4	74	4.9	4.3	59
	5.5	5.2	30	5.5	5.1	63	5.5	4.9	54
	6.0	5.6	31	6.0	5.7	68	6.0	5.4	63
	6.5	6.2	33	6.5	6.0	52	6.5	6.0	51
	6.9	6.8	35	6.9	6.9	0	6.9	6.8	0
	7.4	7.4	0						
Peptone sol.				2.0	2.0	0			
	2.5	2.5	0	2.5	2.5	19	2.5	2.4	0
	2.8	2.5	70	2.8	2.9	120	3.0	3.3	65
	3.4	5.7	178	3.4	4.0	262	3.6	3.6	139
	4.0	5.7	149	3.8	4.0	301	3.9	4.2	293
	4.5	6.5	105	4.0	3.7	289	4.6	4.2	255
	5.0	6.7	116	4.9	4.8	257	5.0	4.9	271
	5.5	6.8	120	5.3	4.8	252	5.4	5.5	224
	6.0	6.8	115	6.0	4.8	253	6.0	4.6	201
	6.6	6.7	125	6.5	5.0	214	6.4	4.8	281
	7.0	7.4	132	7.0	6.5	112	7.0	5.8	187
				7.2	7.1	79			
	7.5	7.5	0	7.8	7.8	0	7.4	7.4	0

as compared to P_H 4.9 and a mat of 74 mgs. at 25° C. and 4.3 and a mat of 56 mgs. at 15° C. The optimal P_H for the two higher temperatures is less acid and not as sharply defined as at 15° C.

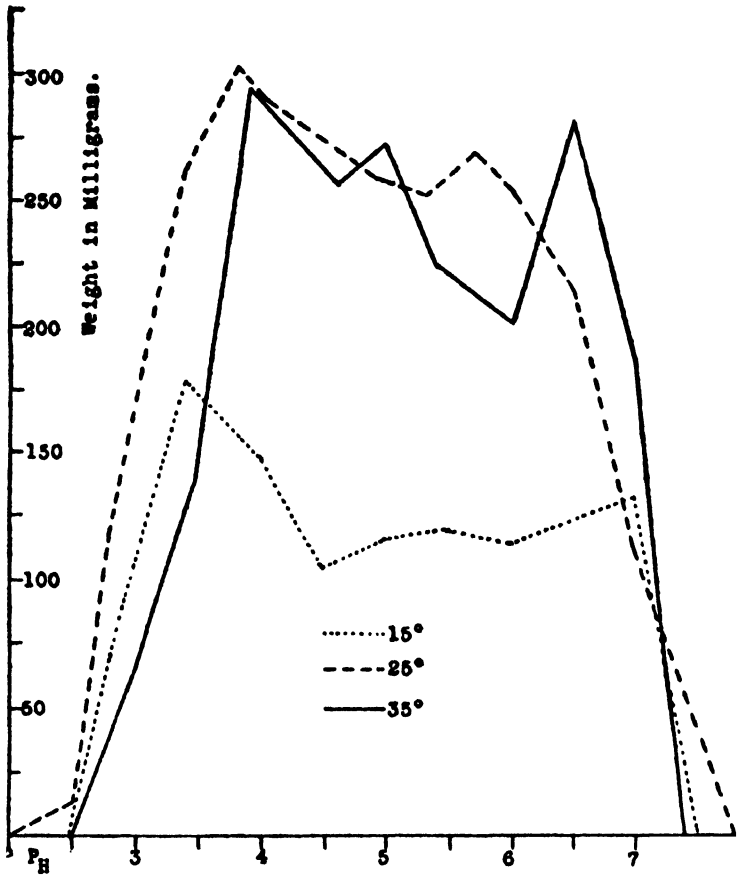

Fig. 6. *Armillaria mellea* in peptone-nutrient solution.

In the peptone solution (fig. 6) growth at 15° C. is noticeably less than at either 25° C. or 35° C., while at these two temperatures the curves are much alike. On the other hand, the growth-zones for 15° C. and 35° C. are practically identical, being P_H 2.5–7.5 in the first case and 2.5–7.4 in the second, as compared to 2.0–7.8 at 25° C. The optimal P_H, 3.4 with a mat weighing 178 mgs. at 15° C., 3.8 with a mat weighing 301 mgs. at 25° C., and 3.9 with a mat weighing 293 mgs. at 35° C., are comparatively

close to the acid limit for growth. In all cases, after passing the optimum, the growth curves gradually and irregularly decrease as the solutions become less acid and fall rapidly to 0 after passing the neutral point.

It is noticeable that both the ranges of growth and the amount of growth expressed in mgs. are greater in the peptone solution

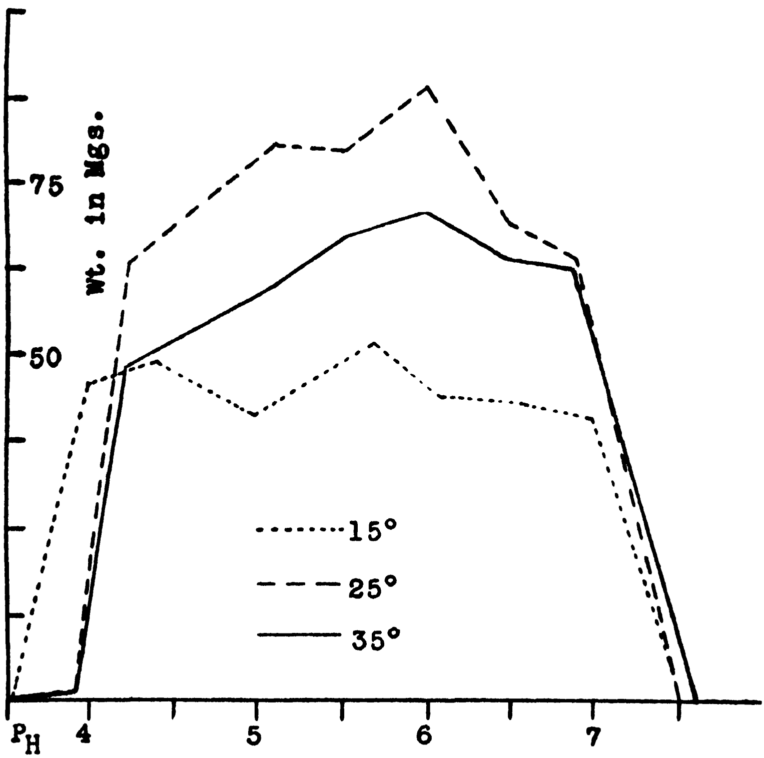

Fig. 7. *Polyporus adustus* in Richards' solution.

than at the corresponding temperatures in the Richards' solution. In both cases growth at 15° C. is less than that at either 25° C. or 35° C. Of these 2 temperatures, although the differences are not pronounced, 25° C. is better as indicated both by increased growth and by wider P_H limits.

Polyporus adustus (table VII) in the Richards' solution (fig. 7) grows best at 25° C. and least at 15° C. At 25° C. growth is inhibited at P_H 3.3 and 7.5, almost the same as at 35° C. where

growth is inhibited at 3.3 and 7.6. At 15° C. the inhibiting reactions are P_H 3.5 and 7.5. At none of the 3 temperatures is there an outstanding maximum, as there is little difference in the amount of growth within the range P_H 4.0–7.0 at 15° C.

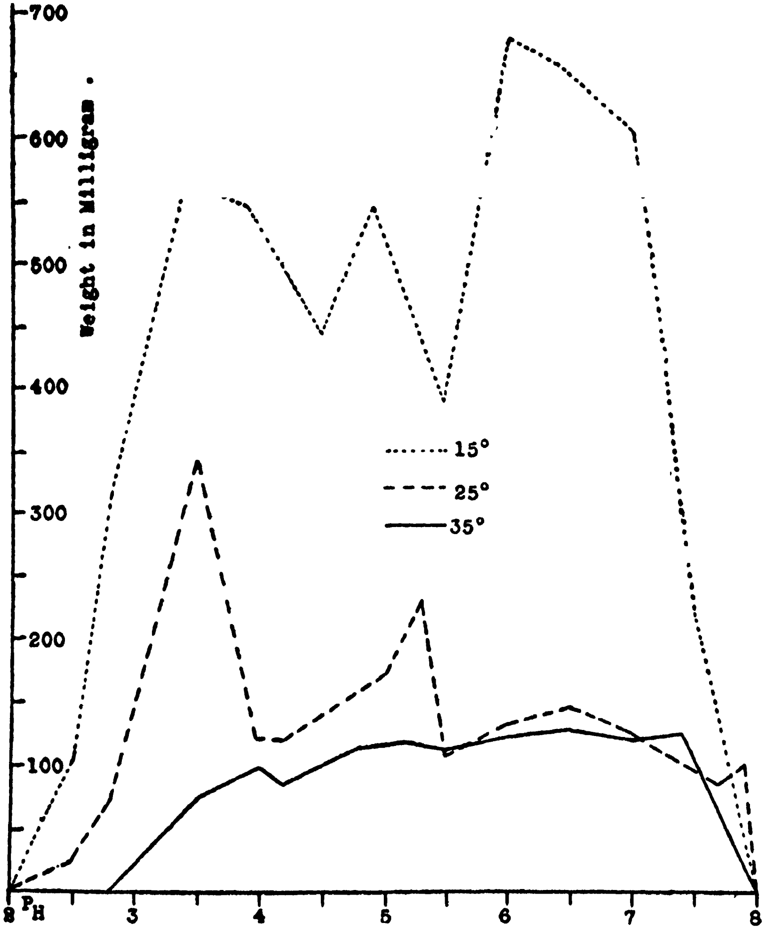

Fig. 8. *Polyporus adustus* in peptone-nutrient solution.

and in the range 4.2–6.0 at 25° C. and 35° C. The active acidity at 15° C. is not materially changed by growth from the initial P_H; at 25° C. it is slightly decreased through the range P_H 3.9–6.0, and increased at 6.5 and 6.9; while at 35° C. it is decreased slightly at 3.9 and 4.2, and increased in the other solutions from 0.2 to 0.6 of a P_H unit.

The most striking fact in the peptone solution (fig. 8) is the marked superiority of growth at 15° C. over that at either of the other 2 temperatures. Although the range of growth in this case is the same as at 25° C., P_H 2.0–8.0, there is no close comparison between the weights of the felts. At 15° C. the optimum range is P_H 3.4–7.0 with a maximum of 679 mgs. at P_H 6.0, while at 25° C. there is a marked optimum at P_H 3.5, with 342 mgs. of growth. The inferiority of 35° C. for growth of this fungus is evidenced both by a reduction in the weights of the mats and by a decrease of the range of growth to P_H 2.8–8.0. No marked optimum is produced, as growth varies slightly from 115 mgs. at P_H 4.8 to 125 mgs. at P_H 7.4, followed by a quick drop to 0 at P_H 8.0. In this solution in most cases the mycelial growth decreases the active acidity of the solution within the P_H range

TABLE VII

THE GROWTH OF POLYPORUS ADUSTUS AND THE CHANGES IN THE ACTIVE ACIDITY UPON BOTH THE RICHARDS' AND THE PEPTONE SOLUTIONS AT DIFFERENT INITIAL P_H AND TEMPERATURES

	15° C.			25° C.			35° C.		
	P_H		Wt. of mat in mgs.	P_H		Wt. of mat in mgs.	P_H		Wt. of mat in mgs.
	Initial	Final		Initial	Final		Initial	Final	
Richards' sol.	3.5	3.5	0	3.3	3.3	0	3.3	3.3	0
	4.0	3.9	46	3.9	4.3	trace	3.9	4.2	trace
	4.4	4.5	49	4.3	5.3	63	4.2	4.2	48
	5.0	4.4	42	5.1	5.7	81	5.1	4.9	60
	5.7	5.8	52	5.5	5.8	80	5.5	5.4	67
	6.1	6.2	44	6.0	6.3	89	6.0	5.4	71
	6.6	6.7	43	6.5	6.4	69	6.5	6.3	64
	7.0	7.2	71	6.9	6.7	64	6.9	6.7	62
	7.5	7.5	0	7.5	7.5	0	7.6	7.6	0
Peptone sol.	2.0	2.0	0	2.0	2.0	0			
	2.5	2.4	105	2.5	2.5	26			
	2.8	2.4	316	2.8	3.1	75	2.8	2.8	0
	3.4	3.0	564	3.5	3.9	342	3.5	6.7	78
	3.9	3.9	546	4.0	6.5	122	4.0	6.2	100
	4.5	6.8	443	4.2	6.3	121	4.2	6.4	89
	4.9	5.8	544	5.0	6.6	174	4.8	6.0	115
				5.3	7.4	230	5.2	6.2	119
	5.5	6.8	390	5.5	6.6	109	5.5	5.6	111
	6.0	4.5	679	6.0	6.0	131	6.0	6.0	123
	6.4	4.9	658	6.5	6.0	145	6.5	5.3	129
	7.0	5.0	602	7.0	6.0	126	7.0	7.6	121
	7.5	7.4	220	7.7	7.2	89	7.4	6.6	125
				7.9	7.8	102			
	8.0	8.0	0	8.0	8.0	0	8.0	8.0	0

2.5–5.5 and increases it within the range 6.5–7.9. The reaction P_H 6.0 remains close to the initial acidity. Some exceptions to this generality are found, for at 15° C. the acidity of the solutions in the P_H range 4.5–5.5 is decreased, while in the remainder of the series the active acidity is increased.

Polyporus adustus at all temperatures produces more growth and grows at a wider range of P_H in the peptone solution than in

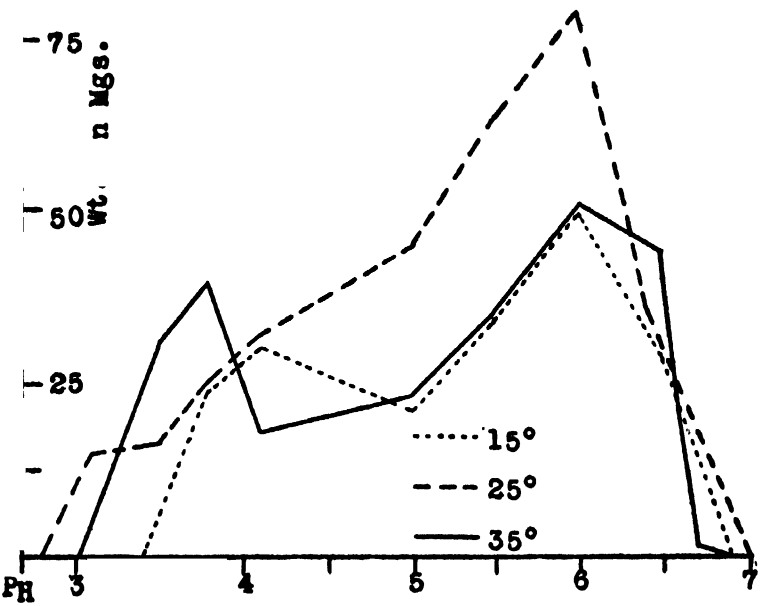

Fig. 9. *Pholiota adiposa* in Richards' solution.

the Richards' solution. While this fungus shows much better growth in the peptone solution at 15° C. than at either of the other 2 temperatures, it grows less at this temperature in the Richards' solution than at either 25° C. or 35° C. Here, however, the variations in growth for the different temperatures are not as marked as they are in the peptone series. As there is no close correlation between the optimal P_H for the two media, since they vary considerably with the temperature and with the solution, it is not possible to designate any definite range of P_H as the optimum for growth of this fungus.

As evidenced by the wider growth limits over those obtained at 15° C. and 35° C., mycelial growth for *Pholiota adiposa* is best at 25° C. as shown in table VIII and fig. 9. Here growth is

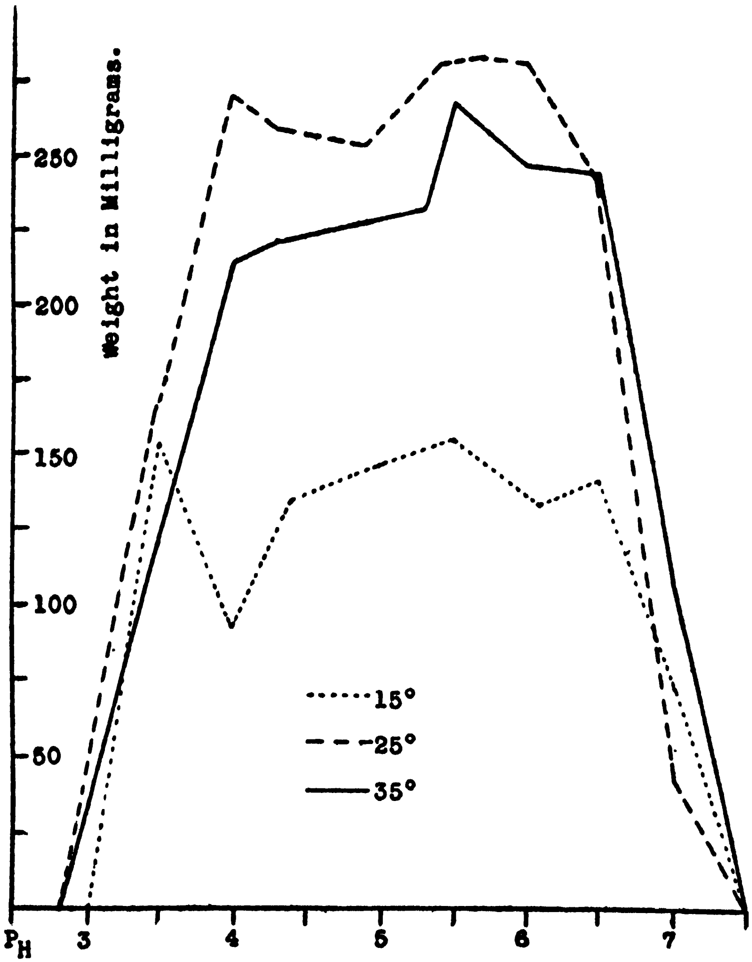

Fig. 10. *Pholiota adiposa* in peptone-nutrient solution.

inhibited by P_H 2.8 and 7.0 as compared with 3.4 and 6.9 for both of the other 2 temperatures. Although the growth curves do not vary a great deal through this entire range they indicate that the greatest amount of growth occurred in the cultures incubated at 25° C. The optimum P_H for the 3 temperatures is 6.0.

In the peptone solution (fig. 10) the P_H limits at 15° C. are 3.0 and 7.5, while at 25° C. and 35° C. they are 2.8 and 7.5. Here the differences in P_H are slight and point to no marked optimum temperature. On the other hand, growth is much more pronounced at 25° C. and 35° C. than at 15° C., and of these 2, 25° C. is the best. In this solution there is no outstanding P_H indicating an optimum hydrogen-ion concentration, for at 15° C. growth varies very little between P_H 3.5 and 6.5 and at 25° C. and 35° C. between 4.0 and 6.5. In solutions either more acid or more alkaline than the above values, *Pholiota adiposa* shows, by a sharp drop in growth, that it is not on a favorable medium with respect to hydrogen-ion concentration.

TABLE VIII

THE GROWTH OF PHOLIOTA ADIPOSA AND THE CHANGES IN THE ACTIVE ACIDITY UPON BOTH THE RICHARDS' AND PEPTONE SOLUTIONS AT DIFFERENT INITIAL P_H AND TEMPERATURES

	15° C.			25° C.			35° C.		
	P_H		Wt. of mat in mgs.	P_H		Wt. of mat in mgs.	P_H		Wt. of mat in mgs.
	Initial	Final		Initial	Final		Initial	Final	
Richards' sol.				2.8	2.8	0			
				3.1	3.3	15	3.0	3.0	0
	3.4	3.4	0	3.5	3.3	17	3.5	3.2	31
	3.8	3.6	24	3.8	3.6	25	3.8	3.4	39
	4.1	4.0	30	4.1	3.5	32	4.1	3.7	18
	5 0	5.0	21	5.0	4.1	45	5.0	5.0	23
	5.5	5.5	34	5.5	4.8	63	5.5	5.3	35
	6.0	6.0	49	6.0	5.4	78	6.0	5.6	51
	6.5	6.4	28	6.4	6.0	36	6.5	6.0	44
	6.9	6.9	0	7.0	7.0	0	6.9	6.9	0
Peptone sol.	3.0	3.0	0	2.8	2.8	0	2.8	2.8	0
	3.5	3.4	154	3.5	4.2	169	3.5	4.8	122
	4.0	4.9	93	4.0	4.0	268	4.0	6.0	214
	4.4	5.3	135	4.3	4.1	258	4.3	6.0	221
	5.0	6.4	146	4.9	4.1	253	4.9	6.4	228
	5.5	6.9	155	5.4	4.4	275	5.3	6.4	232
	6.1	7.0	133	6.0	4.6	275	6.0	6.3	247
	6.5	7.3	142	6.5	4.6	241	6.5	4.6	244
	7.0	7.2	74	7.0	6.6	44	7.0	6.0	106
	7.5	7 5	0	7.5	7.5	0	7.5	7 5	0

In the Richards' solution the growth of this fungus tends to increase slightly the active acidity (table VIII). However, in no case does this increase amount to more than 1 whole P_H unit while in the majority of cases it is less than one-half of a unit.

In the peptone solution there is a tendency to decrease the active acidity at both 15° C. and 35° C. and to increase it at 25° C. At this last temperature, for solutions within the initial P_H range 4.0–6.5, the final P_H varies from 4.0 to 4.6. Growth at P_H 3.5 tends to decrease the acidity to 4.2. On the other hand, at 35° C. the initial P_H range 4.0–6.0 changes to 6.0–6.3. There is an

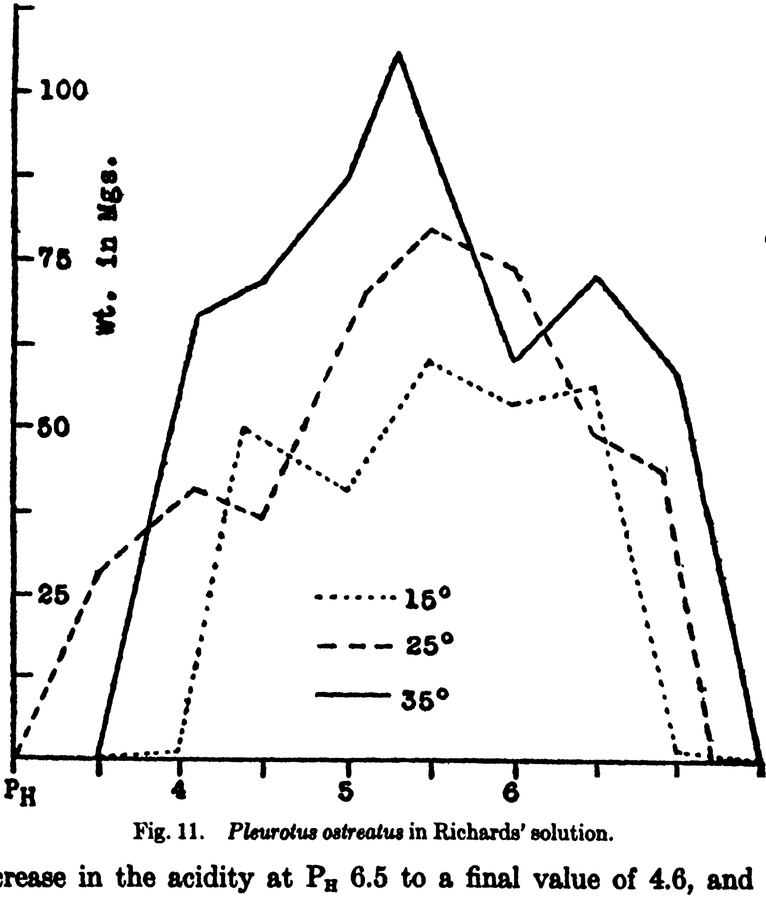

Fig. 11. *Pleurotus ostreatus* in Richards' solution.

increase in the acidity at P_H 6.5 to a final value of 4.6, and a decrease at P_H 3.5 to a final value of P_H 4.8. When one compares the similarity of the growth curves at 25° C. and 35° C. these results are rather unexpected. Throughout the P_H range 4.0–7.0 the decrease in the acidity at 15° C. is less marked than at 35° C.

Upon comparing the growth curves for the 2 solutions, it becomes evident that 25° C. is the optimum temperature of those

employed, and that 35° C. is better on the whole than 15° C. *Pholiota adiposa* also grows better in the peptone solution than in the Richards' solution, producing 4–5 times as much mat in the first solution as is produced in the second. While the fungus grows best at P_H 6.0 in the Richards' medium it does not show any such optimum point in the peptone solution. Furthermore, within the range of these experiments, this fungus does not markedly or invariably decrease or increase the active acidity of the substratum upon which it grows.

The mycelial growth of *Pleurotus ostreatus* (table IX) in the Richards' solution (fig. 11) is limited to a comparatively narrow range of P_H. At 15° C. growth is inhibited at P_H 3.3 and 7.5, but it is evident, however, that the actual limits for growth are nearer to P_H 4.0 and 7.0, as at these values only a trace of growth is obtained. The optimum P_H range at this temperature is 4.4–

TABLE IX

THE GROWTH OF PLEUROTUS OSTREATUS AND THE CHANGES IN THE ACTIVE ACIDITY UPON BOTH THE RICHARDS' AND THE PEPTONE SOLUTIONS AT DIFFERENT INITIAL P_H AND TEMPERATURES

	15° C.			25° C.			35° C.		
	P_H		Wt. of mat in mgs.	P_H		Wt. of mat in mgs.	P_H		Wt. of mat in mgs.
	Initial	Final		Initial	Final		Initial	Final	
Richards' sol.				3.0	3.0	0			
	3.3	3.3	0	3.5	3.3	28	3.5	3.5	0
	4.0	3.7	trace	4.1	3.3	41	4.0	3.7	67
	4.4	4.0	50	4.5	3.3	37	4.5	3.6	72
	5.0	4.0	41	5.1	4.0	70	5.0	4.1	88
	5.5	5.5	61	5.5	4.3	80	5.3	4.1	107
	6.0	6.1	54	6 0	5.3	74	6.0	5.2	60
	6.5	6.8	57	6.5	5.7	49	6.5	5.6	73
	7.0	7.0	trace	6.9	6.2	44	7.0	5.9	58
	7.5	7.5	0	7.2	7.2	0	7.2	7.2	0
Peptone sol.				3.0	3.0	0			
	3.5	3.5	0	3.5	3.5	trace			
	4.1	4.1	46	4.0	6.9	192	4.2	4.2	0
	4 5	4.6	123	4.3	7.0	180			
	5.0	6.4	204	4.9	7.1	136	4.9	5.6	35
	5.5	6.8	194	5.2	6.8	237	5.2	5.8	64
				5.7	6.8	127	5.7	6.3	255
	6.0	7.2	217	5.9	6.7	216	6.0	6.3	207
	6.5	7.3	195	6.4	6.9	142	6.5	7.2	103
	7.0	7.7	155	7.0	7.0	156	7.0	7.9	96
	7.5	8.1	109	7.5	8.4	100	7.5	8.2	90
	8.0	8.0	109	8.0	8.4	86	8.0	8.2	91
	8.5	8.5	0	8.5	8.5	0	8.5	8.5	0

6.5 with maximum growth of 61 mgs. at P_H 5.5 . That 25° C. is more favorable for growth of this fungus than 15° C. is indicated both by the widened range of P_H and by the heavier mats. Here growth is not inhibited until P_H 3.0 is reached on the acid side and until 7.2 is reached on the alkaline side, while best growth is

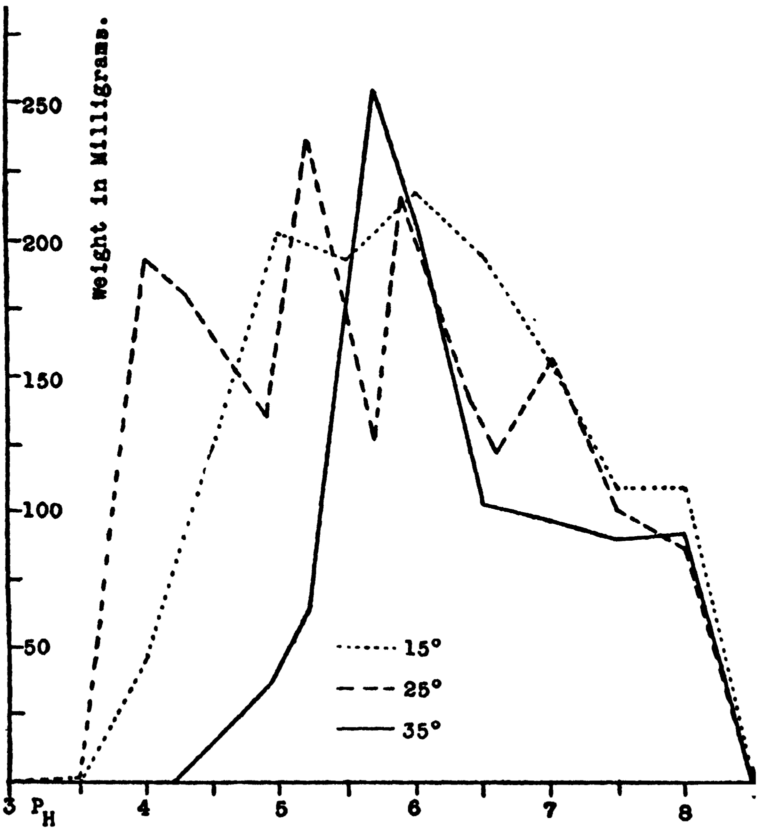

Fig. 12. *Pleurotus ostreatus* in peptone-nutrient solution.

obtained at P_H 5.5 with 80 mgs. Growth of this species is less tolerant to an acid medium at 25° C. than it is at 35° C., but in an alkaline medium, on the other hand, the fungus grows better at the lower of the 2 temperatures. For the 3 temperatures, as indicated by the growth curves, the optimum P_H range is 5.0–6.5.

In the peptone solution (fig. 12), using the amount of growth as an indicator, it is difficult to pick out any optimum temperature,

but from the standpoint of range of P_H, 25° C. is a little better than 15° C. and considerably better than 35° C. Although at this medium temperature the growth curve fluctuates, making it difficult to determine the optimum range, the 2 high points lie at P_H 5.2 and 5.9. At 35° C., however, there is a very sharp optimum of 255 mgs. at P_H 5.7, as compared with 237 mgs. at P_H 5.2, and 216 mgs. at P_H 5.9 for 25° C., and 217 mgs. at P_H

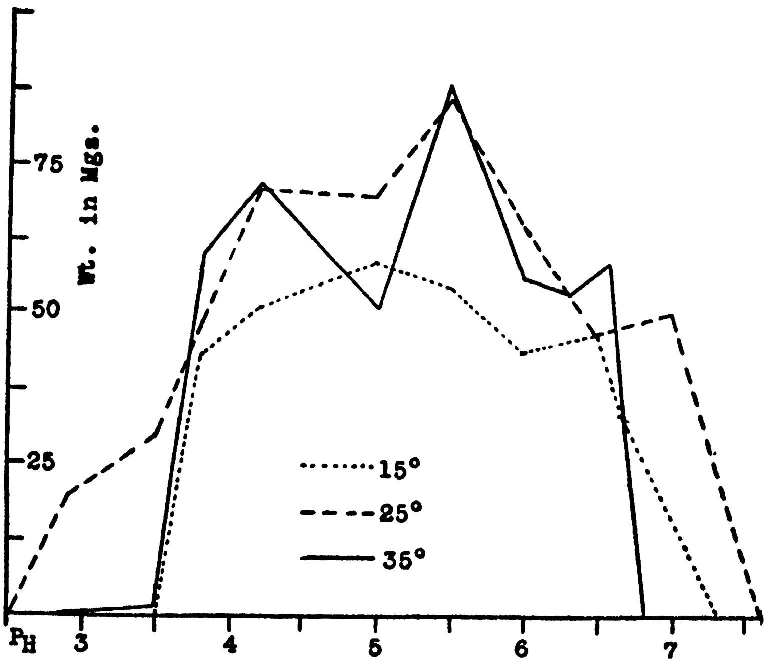

Fig. 13. *Polystictus versicolor* in Richards' solution.

6.0 for 15° C. Although the fungus may be a little more tolerant to acid at 25° C. than at 15° C., a comparison of the P_H limits and of the optimum range show that there are no fundamental differences in the growth curves of these 2 temperatures.

While the active acidity in the Richards' solution is slightly increased in the majority of cases, in the peptone solution it is invariably decreased close to neutrality or to slight alkalinity. In the former solution, within the P_H range at which *Pleurotus ostreatus* grows, the final P_H at 25° C. varies from 3.3 to 6.2, while in the latter solution the final range at the same temperature

varies from 6.9 to 8.4. This well indicates the different reaction within the 2 types of media.

The marked tolerance to slight alkalinity and the greater amount of growth in the peptone solution show that this medium is much the better of the two. In the Richards' solution there is no indication that this fungus will grow on an alkaline media, while the average weight of the mats is about one-fourth of the average for those obtained in the peptone solution. Although 35° C. is the most favorable for growth of this fungus in the Richards' medium, there is no sharp difference between the 3 temperatures in the peptone medium. Here 35° C. is not as favorable as either 25° C. or 35° C., from the standpoint of P_H range, but it is a little better when considered from the amount of growth at the optimum P_H. With some individual variations, *Pleurotus ostreatus* shows, as indicated in both media, an optimum range between P_H 5.0 and 6.5.

Because of the wider range of growth at 25° C., this temperature is the optimum for growth of *Polystictus versicolor* in the Richards' solution (see table x and fig. 13). The P_H limits at this temperature are 2.5 and 7.6, as compared with 3.5 and 7.3 for 15° C., and 2.9 and 6.8 for 35° C. Maximum growth at 25° C. is obtained at P_H 5.5 with a mat weighing 86 mgs. On either side of the optimum zone, P_H 4.2–6.0, growth drops off rapidly. At the lowest temperature the optimum growth-zone is P_H 3.8–6.5 and, while there is no outstanding optimum P_H, growth is better at 5.0 with a mat of 59 mgs. than at any other point within the optimum range. At 35° C. the fungus produces an optimum at 5.5 with 88 mgs. and an optimum zone between P_H 4.2 and 6.6.

This same fungus in the peptone solution (fig. 14) grows a little better at 15° C. than at 25° C. and much better than at 35° C. At the 2 lower temperatures the P_H limits are practically identical, being 2.5 and 7.4 for 15° C. and 2.5 and 7.5 for 25° C. At 35° C. there is a marked narrowing of the limits on the acid side, the range being P_H 3.0–7.5. At 25° C. and 15° C. marked optima are shown in the growth curves, the first being at P_H 3.5 with 505 mgs. and the second at P_H 4.0 with 507 mgs. The optimum is not so pronounced for 35° C., ranging from P_H 4.0 to 4.9 with 316 and 304 mgs.

TABLE X

THE GROWTH OF POLYSTICTUS VERSICOLOR AND THE CHANGES IN THE ACTIVE ACIDITY UPON BOTH THE RICHARDS' AND THE PEPTONE SOLUTIONS AT DIFFERENT INITIAL P_H AND TEMPERATURES

	15° C.			25° C.			35° C.		
	P_H		Wt. of mat in mgs.	P_H		Wt. of mat in mgs.	P_H		Wt. of mat in mgs.
	Initial	Final		Initial	Final		Initial	Final	
Richards' sol.				2.5	2.5	0			
				2.9	2.9	20	2.9	2.9	0
	3.5	3.5	0	3.5	3.4	30	3.5	3.3	trace
	3.8	3.7	43	3.8	3.5	48	3.8	3.6	60
	4.2	3.6	51	4.2	3.4	71	4.2	3.8	72
	5.0	4.6	59	5.0	3.6	70	5.0	4.2	51
	5.5	5.2	55	5.5	5.0	86	5.5	5.2	88
	6.0	5.9	44	6.0	5.5	65	6.0	5.5	57
	6.5	6.2	47	6.5	5.7	47	6.3	5.5	54
	6.7	6.7	32	7.0	6.2	50	6.6	6.0	59
	7.3	7.3	0	7.6	7.6	0	6.8	6.8	0
Peptone sol.	2.5	2.5	0	2.5	2.5	0			
	3.0	3.0	105	3.0	2.8	50	3.0	3.0	0
	3.5	3.5	402	3.5	4.2	505	3.5	4.4	195
	4.0	5.2	507	4.0	3.8	337	4.0	4.0	316
	4.5	5.6	414	4.2	4.0	320	4.2	4.0	307
	5.0	5.3	441	4.9	4.7	303	4.9	4.8	304
				5.3	5.0	378	5.2	5.0	260
	5.5	5.4	373	5.5	4.9	376	5.5	5.1	273
	6.0	4.5	410	6.0	5.0	395	6.0	5 0	243
	6.5	4.7	374	6.5	4.8	244	6.5	5.0	205
	7.0	5.2	208	7.0	6.7	137	6.8	5.2	119
	7.4	7.4	0	7.5	7.5	0	7 5	7.5	0

This species tends to increase the active acidity of the solutions in which it grows. In every case in the Richards' solution the acidity is slightly increased, usually less than 1 P_H unit. In the peptone solution, with a few exceptions in the more acid range, this tendency persists, the amount of increase, as in the Richard's solution, being less than 1 unit. Comparing the 2 solutions, however, the increase is greater in the peptone solution.

When comparing the growth in the 2 media it becomes evident that the peptone solution is much the better. With peptone as the source of nitrogen, *Polystictus versicolor* produces some 5 to 6 times as much mat as when an inorganic salt is the source of nitrogen. The range of growth in the peptone solution is not materially widened on the alkaline side except at 35° C., but on the acid side it is markedly widened for 15° C. and 35° C. For 25° C. it remains the same in both solutions. It is evident that

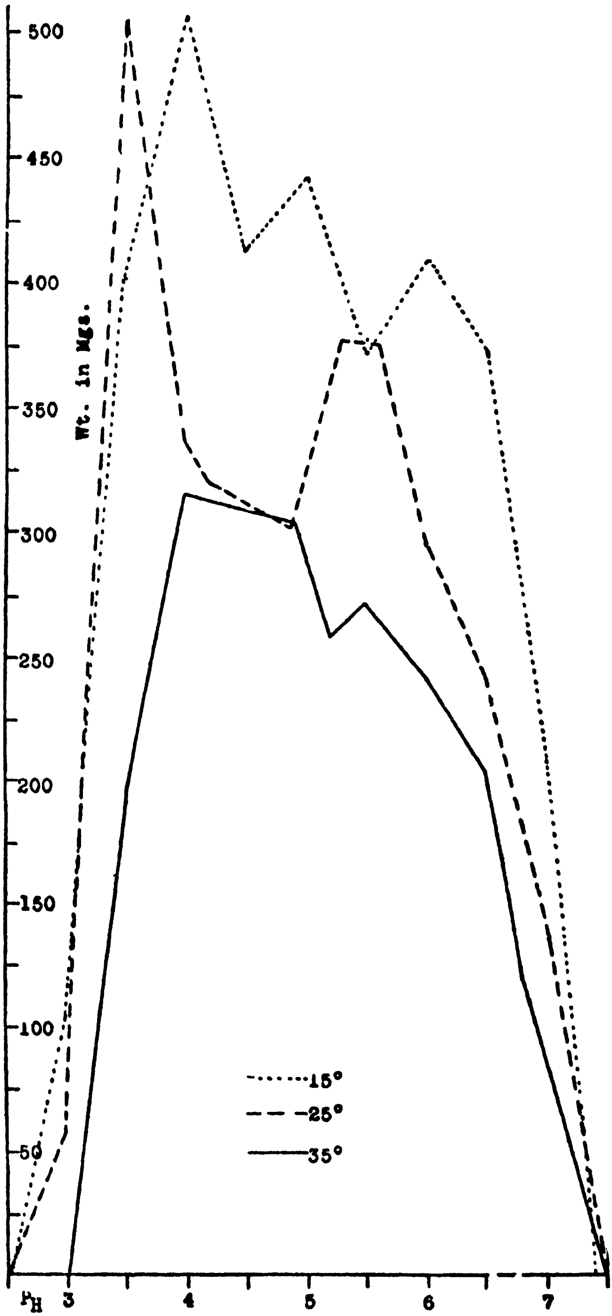

Fig. 14. *Polystictus versicolor* in peptone-nutrient solution.

the optimum temperature in the one solution is not necessarily the optimum in the other, for in the Richards' solution the fungus shows poorest growth at 15° C., while in the peptone solution it shows best growth at this same temperature. The poorest results are given at 35° C. in the peptone solution and intermediate in the Richards' solution. The optimal P_H range in the peptone is

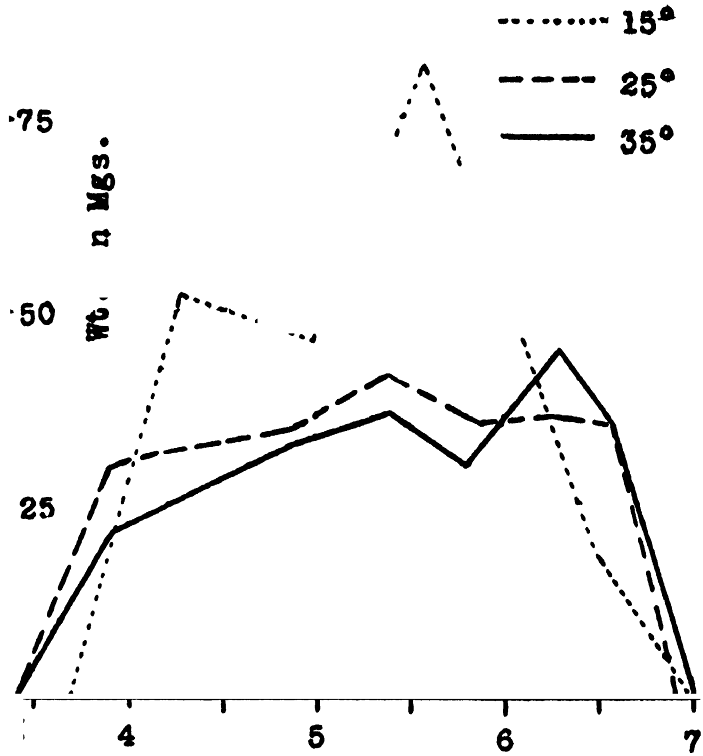

Fig. 15. *Schizophyllum commune* in Richards' solution.

somewhat more acid than that in the Richards' solution, in the first case being close to the zone P_H 3.5–5.0 and in the second, to the zone 4.0–6.5. Except at the 2 lower temperatures in the peptone solution, there is no indication of a marked optimum P_H.

Although the P_H range at 15° C. is somewhat narrower than at the other 2 temperatures, *Schizophyllum commune* (table XI) grows best at this temperature in the Richards' solution (fig. 15). Here the P_H limits are 3.7 and 7.0, while at 25° C. and 35° C.

they are 3.4 and 6.9 and 3.4 and 7.0. Only at 15° C. is there any indication of a pronounced optimum P_H, this being 5.6 with 82 mgs. of growth. At the 2 higher temperatures the optimum growth-zone is P_H 4.9–6.5, while at 15° C. it is somewhat narrower, being 4.3–6.0.

TABLE XI

THE GROWTH OF SCHIZOPHYLLUM COMMUNE AND THE CHANGES IN THE ACTIVE ACIDITY UPON BOTH THE RICHARDS' AND THE PEPTONE SOLUTIONS AT DIFFERENT INITIAL P_H AND TEMPERATURES

	15° C.			25° C.			35° C.		
	P_H		Wt. of mat in mgs.	P_H		Wt. of mat in mgs.	P_H		Wt. of mat in mgs.
	Initial	Final		Initial	Final		Initial	Final	
Richards' sol.				3.4	3.4	0	3.4	3.4	0
	3.7	3.7	0	3.9	3.6	30	3.9	3.7	22
	4.3	3.7	52	4.2	3.6	32	4.3	3.8	26
	5.0	3.8	47	4.9	3.7	35	4.9	3.8	33
	5.6	4.5	82	5.4	3.8	42	5.4	4.6	37
	6.0	5.4	54	5.9	4.6	36	5.8	5.1	30
	6.5	6.4	18	6.3	5.6	37	6.3	5.5	45
				6.6	6.4	35	6.5	5.8	38
	7.0	7.0	0	6.9	6.9	0	7.0	7.0	0
Peptone sol.	2.8	2.8	0	2.8	2.8	0	2.9	2.9	0
	3.5	3.5	trace	3.5	3.6	248	3.5	3.5	97
	3.9	4.7	687	4.0	5.8	569	4.0	5.8	327
	4.6	5.7	844	4.4	6.0	645	4.4	6.1	483
	5.0	5.9	884	4.9	6.0	671	5.0	5.8	388
	5.5	5.9	880	5.4	6.0	645	5.3	5.9	391
	6.0	5.8	866	5.6	6.0	742	5.6	5.9	289
				6.0	5.8	560	6.0	6.3	512
	6.6	5.9	553	6.4	5.9	542	6.7	6.4	465
	7.0	5.9	431	6.9	5.9	550	7.0	6.4	400
	7.6	6.3	391	7.8	6.2	511	7.5	6.5	305
	8.0	6.5	196				8.0	8.0	0
	8.5	8.5	0	8.5	8.5	0			

In the peptone solution (fig. 16) the fungus again shows optimum growth at 15° C. with a range from P_H 2.8 to 8.5. This is a narrower range on the acid side than that for either 25° C. or 35° C. but a wider range on the alkaline side than for 35° C.; the intermediate temperature having a range from P_H 2.8–8.5 and the higher from 2.9 to 8.0. The optimum P_H zone at 15° C. is 4.6–6.0 with a maximum of 884 mgs. at P_H 5.0, and at 25° C. it is 4.4–5.6 with a maximum of 742 mgs. at P_H 5.6. At 35° C. the growth curve fluctuates widely through a range of 200 mgs. between P_H 4.4 and 7.5, making it difficult to show either an

optimum zone or optimum P_H, but better growth is obtained at P_H 6.0 with 512 mgs. than at either of the other 2 high points, P_H 4.4 and 6.7.

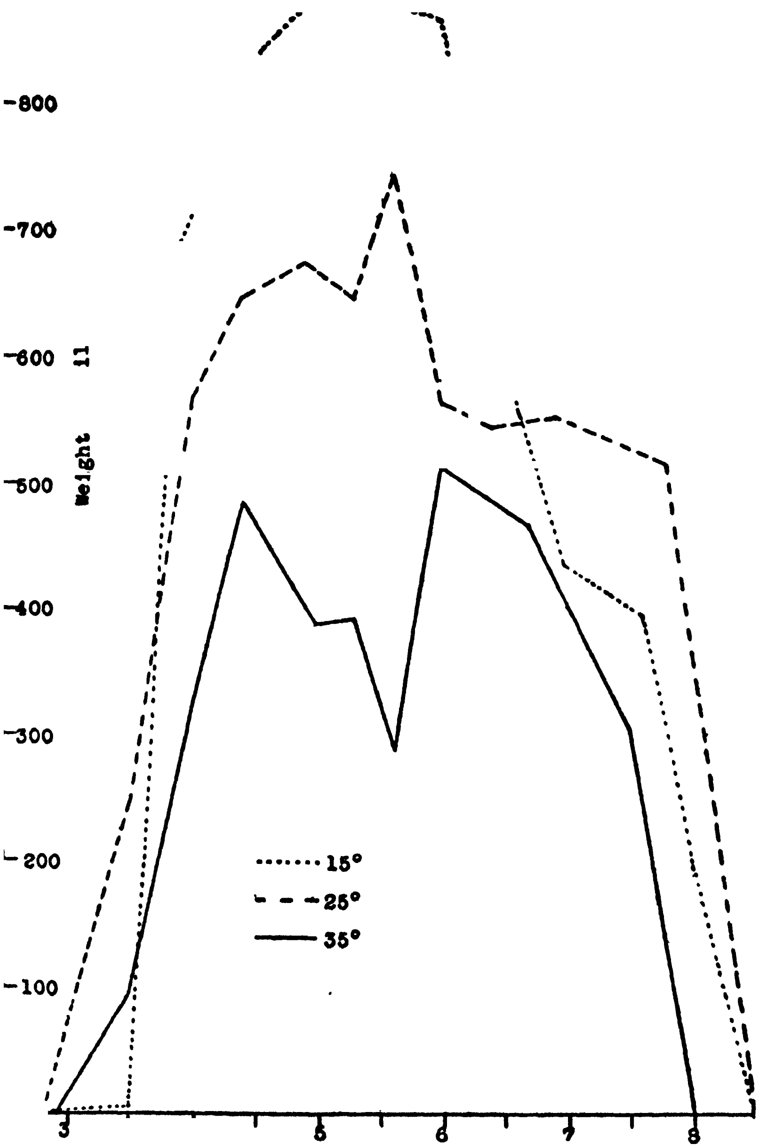

Fig. 16. *Schizophyllum commune* in peptone-nutrient solution.

The mycelial growth of *Schizophyllum commune* tends to increase the active acidity of the Richards' solution throughout the entire P_H range and at all temperatures. The degree of increase is not pronounced in any case, the highest being 1.6 P_H units and the lowest 0.1 unit, while the majority of changes are less than 1 unit. In the peptone solution, on the other hand, there is a tendency to decrease the acidity of all solutions with an initial acidity greater than P_H 6.0 and to increase it when the initial acidity is less than this figure. The initial reaction, P_H 6.0, at the 2 lower temperatures is slightly increased, while at the highest temperature it is slightly decreased. Within the initial range used in these experiments, growth between P_H 4.0 and 8.0 tends to produce a final range from P_H 3.7–6.5. In the Richards' solution, on the other hand, this tendency to change the acidity to approximately P_H 6.0 is not evident, as the final P_H range is more acid than the initial.

The most outstanding feature in comparing *Schizophyllum commune* in the 2 solutions is that in the peptone medium the fungus grows from 15 to 20 times better than in the Richards' solution. It shows optimum growth in both cases at 15° C. and poorest at 35° C. The differences are not so marked, however, in the Richards' solution as in the peptone solution where the inferiority of 35° C. for growth is quite noticeable. The optimum P_H range for both solutions lies between 4.0 and 6.0, with little or no evidence that the fungus tends to grow better at any one P_H than at any other within this zone.

The results, from cultures at 25° C. in a 0.5 per cent peptone-nutrient solution at initial acidity of P_H 3.0, 4.0, 5.0, 6.0, and 7.0 (table XII, figs. 17 and 18), indicate that in every case except for *Pholiota adiposa* the fungi grow best when the initial P_H is 4.1. This one fungus grows better at P_H 5.0. *Pleurotus ostreatus* (fig. 17) and *Daedalea confragosa* (fig. 18) grow more actively than the other 6 species, reaching 139 mgs. at P_H 4.0 and 135 mgs. at P_H 5.0 in the first case, and 127 mgs. at P_H 4.0 and 118 mgs. at P_H 5.0 in the second. These same 2 fungi fail to grow at P_H 3.0, while all of the other species produce some felt at this acidity. These other 6 species are closely grouped with respect to the amount of growth, all being able to utilize peptone as a source of carbon.

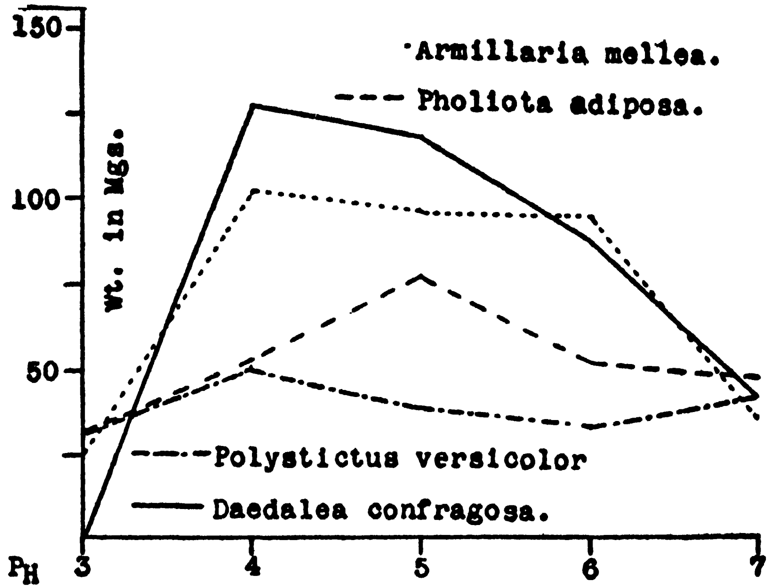

Fig. 17. *Armillaria mellea, Pholiota adiposa, Polystictus versicolor*, and *Daedalea confragosa* in a peptone-nutrient solution without sugar and at 25° C.

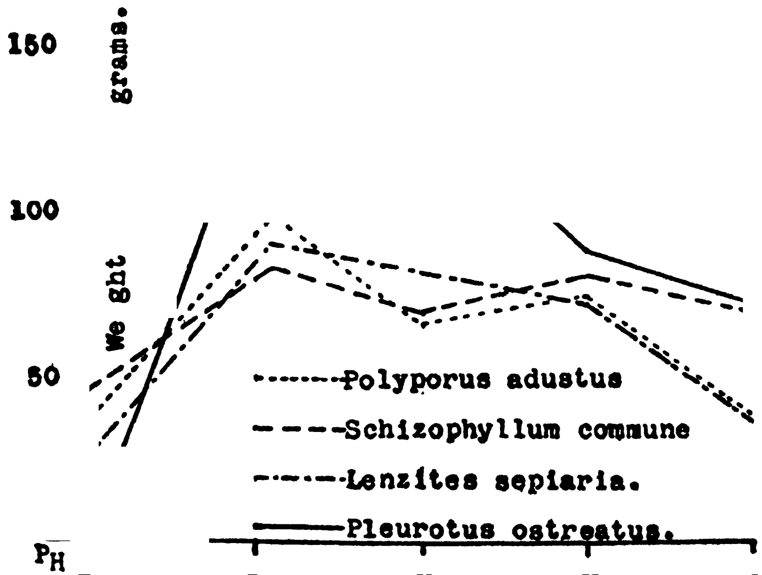

Fig. 18. *Polyporus adustus, Schizophyllum commune, Lenzites sepiaria*, and *Pleurotus ostreatus* in a peptone-nutrient solution without sugar and at 25° C.

TABLE XII

GROWTH AND CHANGES IN THE ACTIVE ACIDITY AT 25° C. AND AT DIFFERENT INITIAL P_H IN A SOLUTION WITH PEPTONE AS THE ONLY SOURCE OF CARBON AND NITROGEN

Fungi											
Schizophyllum commune			Polyporus adustus			Lenzites sepiaria			Pleurotus ostreatus		
P_H		Wt. of mat in mgs.	P_H		Wt. of mat in mgs.	P_H		Wt. of mat in mgs.	P_H		Wt. of mat in mgs.
3.0	3.0	47	3.0	3.0	37	3.0	3.0	24	3.0	3.0	0
4.1	5.6	84	4.1	6.6	99	4.1	6.6	91	4.0	7.3	139
5.0	5.9	70	5.0	6.0	67	5 0	6.7	82	5.0	7.2	135
6.0	6.0	62	6.0	6.6	75	6.0	7.3	73	6.0	7.9	89
7.0	6.7	70	7.0	6.9	40	7.0	7.2	39	7.0	8.0	78
Pholiota adiposa			Armillaria mellea			Polystictus versicolor			Daedalea confragosa		
3.0	3.5	31	3.0	3.2	25	3.0	3.1	31	3.0	3.0	0
4.0	5 6	53	4.0	6.6	102	4.0	5.4	51	4.0	6.6	127
5.0	6.8	76	5.0	6.7	96	5.0	5.5	39	5.0	6.8	118
6.0	7.0	53	6.0	7.4	95	6 0	5.4	33	6 0	6.9	89
7 0	7.4	49	7 0	7.4	36	7.0	7 5	41	7.0	7 2	41

In every case the active acidity of the solutions with the initial P_H 3.0 is not materially altered by growth, while in the majority of cases in those solutions with an initial acidity of P_H 4.0, 5.0, and 6.0, the active acidity is reduced close to neutrality. Exceptions to this are: *Polystictus versicolor* at P_H 6.0, *Polyporus adustus* at P_H 7.0, and *Schizophyllum commune* at P_H 6.0 and 7.0. In these cases the active acidity is slightly increased. The acidity is decreased less by *Polystictus versicolor* and more by *Pleurotus ostreatus* than by the other species, the final values ranging from 5.4 to 5.5 in the first case and from 7.2 to 8.0 in the second.

The use of filter-paper strips and cellulose suspensions in cultures made it necessary to form some standard for measuring the amounts of growth other than by the dry weights of the mats. This was accomplished by comparing the growth in the cultures with a definite scale ranging from 0 to 5, where 0 designates no growth; 1, traces of submerged growth; 2, submerged growth more than in 1 but less than 50 per cent of the surface covered; 3, as in 2 but the surface more than 50 per cent and less than 100 per cent covered; 4, as in 2 but the surface entirely covered by a thin film of mycelium; and 5, surface covered by a thicker mat than in

4. This criterion is used throughout the series where celluloses are used in liquid cultures.

The hydrolysis of the filter-paper is also measured according to a definite scale ranging from 0 to 6, where 0 represents no utilization as evidenced by the intact strips; 1, strips appear intact but are rather easily shredded upon being touched; 2, more than 75 per cent of the strips are intact, but 25 per cent are already partially decomposed and shredded; 3, more than 50 per cent and less than 75 per cent of the strips are intact; 4, more than 25 per cent but less than 50 per cent of the strips are intact and less than 25 per cent completely shredded; 5, less than 25 per cent of the strips are intact, but more than 25 per cent and less than 50 per cent are completely decomposed; and 6, the strips are entirely decomposed into a fibrous condition.

Table XIII shows that all the fungi are able to some extent to utilize filter-paper as a source of carbon. Some species, such as *Armillaria mellea* and *Polystictus versicolor*, throughout the entire P_H range from 3.0 to 7.0, show considerable hydrolysis of the paper, more than half of the strips being dissolved and partially utilized. Other forms, such as *Daedalea confragosa*, *Pleurotus ostreatus*, and *Polyporus adustus*, show less utilization of the paper cellulose. *Lenzites sepiaria*, *Schizophyllum commune*, and *Pholiota adiposa* make minimum use of this source of carbon. In only one case, *Pholiota adiposa* at P_H 5.0, is over 50 per cent of the cellulose dissolved, while with the other 2 species, *Lenzites sepiaria* and *Schizophyllum commune*, more than 75 per cent of the strips are left intact or are only slightly shredded after 30 days. *Schizophyllum commune*, *Daedalea confragosa*, and *Pleurotus ostreatus* do not grow at P_H 3.0, while all of the other species are capable of a small amount of growth at this acidity. *Polyporus adustus*, *Daedalea confragosa*, *Pleurotus ostreatus*, and *Armillaria mellea* grow as well at P_H 7.0 as at any other P_H, while the other species are characterized by maximum mycelial growth and utilization of the filter-paper at the intermediate reactions.

Although there is some considerable variation in P_H, all species except *Polystictus versicolor* reduce the active acidity of the more acid solutions. *Daedalea confragosa*, *Armillaria mellea*, *Schizophyllum commune*, and *Polyporus adustus* slightly increase the

TABLE XIII

GROWTH AT 25° C. AND UTILIZATION OF FILTER-PAPER AS THE SOURCE OF CARBON IN A WEAK PEPTONE SOLUTION WITH DIFFERENT INITIAL P_H

	Polystictus versicolor			Polyporus adustus			Schizophyllum commune			Lenzites sepiaria		
Initial P_H	Final P_H	Mycelial growth	Paper utilization	Final P_H	Mycelial growth	Paper utilization	Final P_H	Mycelial growth	Paper utilization	Final P_H	Mycelial growth	Paper utilization
3.0	3.2	3	3	5.0	3	1	3.4	0	0	3.6	2	1
4.0	4.6	4	5	5.9	3	1	5.7	5	2	6.2	3	2
5.0	4.5	5	5	5.8	4	3	6.0	5	2	6.2	3	2
6.0	4.7	4	4	5.9	3	3	6.0	3	1	6.7	3	2
7.0	6.2	2	3	5.6	4	4	6.3	2	1	7.8	2	1
	Daedalea confragosa			Pleurotus ostreatus			Pholiota adiposa			Armillaria mellea		
3.0	2.8	0	0	2.8	0	0	5.7	2	1	3.8	4	4
4.0	6.1	4	3	6.0	5	3	5.5	4	2	4.5	5	5
5.0	5.9	4	3	6.1	5	3	5.0	5	3	5.0	5	5
6.0	5.2	5	4	6.6	5	3	6.6	4	2	4.6	5	5
7.0	6.3	3	3	7.7	5	3	7.8	2	1	4.3	4	5

active acidity of the solutions with an initial P_H 6.0 and 7.0. *Pholiota adiposa, Lenzites sepiaria,* and *Pleurotus ostreatus,* on the other hand, tend to change the initial P_H 6.0 toward neutrality and the initial P_H 7.0 to slight alkalinity. The direction and amount of change in the active acidity vary with the fungus under consideration and with the initial P_H of the solution.

Polyporus adustus, Polystictus versicolor, Schizophyllum commune, Lenzites sepiaria, and *Pleurotus ostreatus* grow slowly in the Richards' solution where cellulose from different species of wood is used as the source of carbon (table XIV). Without an exception the bulk of the growth is beneath the surface of the solution in close contact with the cellulose, forming an inseparable mass. In no case is growth obtained at P_H 2.9, while in the majority of instances maximum growth occurs at P_H 5.0 and 6.0. Of the 5 species, *Lenzites sepiaria* makes the poorest growth throughout and fails to grow at all upon cellulose from poplar wood. *Pleurotus ostreatus* and *Polyporus adustus,* on the other hand, show most active growth. In both of these cases growth is less vigorous on pine-wood cellulose than on the other celluloses

from maple, oak, and poplar woods. *Polyporus adustus* grows best on poplar-wood cellulose, and *Pleurotus ostreatus* on cellulose derived from either maple or poplar woods. *Polystictus versicolor* and *Schizophyllum commune*, while growing less vigorously than either of the other 2 species, do not show decreased growth when pine-wood cellulose is used.

In every case the acidity of the solutions is but slightly changed; where the initial is P_H 4.0, the final is 3.5 to 4.1; where the initial is P_H 5.0, the final is 4.3 to 4.2; and where the initial is P_H 6.0, the final is 5.6 to 6.4. In only one case, *Polystictus versicolor* in maple-wood cellulose, is the final acidity increased where the initial is P_H 6.0, while in just one instance, *Polyporus adustus* in poplar-wood cellulose, is the final acidity decreased where the initial is P_H 5.0. There is no indication that any fungus tends to decrease or increase the active acidity with any degree of regularity.

TABLE XIV

GROWTH AT 25° C. AND AT DIFFERENT INITIAL P_H IN A MODIFIED RICHARDS' SOLUTION WITH CELLULOSE AS THE SOURCE OF CARBON

	Fungi									
	Polyporus adustus		Polystictus versicolor		Schizophyllum commune		Lenzites sepiaria		Pleurotus ostreatus	
Initial P_H	Final P_H	Mycelial growth	Final P_H	Mycelial growth	Final P_H	Mycelial growth	Final P_H	Mycelial growth	Final P_H	Mycelial growth
2.9	2.9	0	2.8	0	2.9	0	2.9	0	2.9	0
4.0	3.9	1	4.1	2	3.9	1	4.1	2	3.8	1
5.0	4.5	2	4.5	3	4.5	2	4.8	2	4.6	2
6.0	5.7	2	6.0	2	6.3	2	6.0	1	6.4	3
2.9	2.9	0	2.8	0	3.0	0	3.0	0	2.9	0
4.0	3.9	1	3.6	2	4.0	1	4.0	1	3.8	2
5.0	5.2	2	4.6	3	4.5	2	4.5	2	4.3	4
6.0	6.3	3	5.6	2	6.1	2	6.2	1	6.2	4
2.9	2.8	0	2.9	0	2.9	0	2.9	0	2.9	0
4.0	3.5	1	4.0	1	3.9	1	4.0	1	3.8	1
5.0	4.9	2	4.6	2	4.6	1	4.8	1	4.8	3
6.0	6.0	3	6.2	0	6.2	2	6.2	2	6.2	3
2.9	—	—	—	—	—	—	—	—	—	—
4.0	4.0	2	4.0	1	4.0	0			4.0	1
5.0	5.1	4	4.5	3	4.8	0			5.0	4
6.0	6.2	3			6.0	0				

When this Richards' solution with the same celluloses as the sources of carbon is solidified with 2 per cent agar and inoculated, the diametric growth of these same 5 species of fungi is slow. It is characterized by a very thin superficial layer of mycelium and by clearing of the agar, denoting utilization of cellulose. The growth in diameter, both of the fungi and of the clear zones, was measured every other day for 18 days, when all growth had stopped, due to the drying of the agar. As the intervening measurements simply show successively increasing growth without any striking departures from the normal, the final figures, as obtained at the end of 18 days, are the only ones presented in table xv.

TABLE XV

DIAMETRIC GROWTH OF THE FUNGI AND OF THE CLEAR ZONES IN A MODIFIED RICHARDS' SOLUTION SOLIDIFIED WITH 2 PER CENT AGAR AND WITH CELLULOSE AS THE SOURCE OF CARBON. MEASUREMENTS GIVEN IN MILLIMETERS

	Fungi									
	Polystictus versicolor		Pleurotus ostreatus		Schizophyllum commune		Polyporus adustus		Lenzites sepiaria	
Initial P_H	Diameter of mycelial growth	Diameter of clear zone	Diameter of mycelial growth	Diameter of clear zone	Diameter of mycelial growth	Diameter of clear zone	Diameter of mycelial growth	Diameter of clear zone	Diameter of mycelial growth	Diameter of clear zone
2.8	0	0	0	0	0	0	0	0	0	0
4.0	70	48	61	25	68	60	75	*	0	0
4.6	80	41	70	74	80	70	90	60	0	0
5.0	26	0	62	65	62	56	80	65	0	0
6.0	65	32	70	65	55	60	80	40	0	0
2.8	0	0	0	0	0	0	0	0	0	0
4.0	0	0	61	22	0	0	52	30	0	0
4.6	0	0	65	35	46	*	75	30	0	0
5.0	0	0	32	*	47	*	74	60	0	0
6.0	0	0	68	*	42	*	65	55	0	0
2.8	0	0	0	0	0	0	0	0	0	0
4.0	0	0	60	*	48	*	58	30	0	0
4.6	78	35	65	78	70	30	75	70	0	0
5.0	70	35	70	65	40	40	76	60	0	0
6.0	62	38	73	72	55	45	77	75	0	0
2.8	0	0	0	0	0	0	0	0	0	0
4.0	0	0	29	0	36	*	21	0	0	0
4.6	0	0	75	40	69	*	85	60	0	0
5.0	0	0	83	50	41	*	70	35	0	0
6.0	0	0	70	58	36	*	0	0	0	0

* No definite clear zone.

In no case is growth secured in the most acid plates, those with an initial P_H of 2.8. *Lenzites sepiaria* does not grow under any condition and apparently is unable to utilize the cellulose contained in the agar. *Polystictus versicolor* grows and utilizes the cellulose from both poplar and maple woods but not from pine and oak woods, while the other 3 species will grow to some extent upon celluloses derived from the 4 types of wood. There is some doubt as to the utilization of cellulose from pine and oak woods by *Schizophyllum commune*, for in this, and in a few others, the plates remained cloudy in spite of the comparatively active growth. *Pleurotus ostreatus*, one of the most active users of cellulose, does not avail itself of the carbon from the pine-wood cellulose as readily as of the other forms of cellulose, while *Polyporus adustus* does not show this difference. Most active growth and hydrolysis are secured in those plates with an initial P_H of 4.6, 5.0, and 6.0. In some cases, however, as with *Schizophyllum commune* and *Polystictus versicolor* on poplar-wood celluloses, growth of the fungi and utilization of the cellulose are as marked at P_H 4.0 as in the less acid plates.

Discussion

All of the fungi used in these experiments show growth through a considerable range of hydrogen-ion concentration. A brief review of the facts, as previously presented, show that the fungi studied are partial to acid media, and that in the majority of cases they fail to grow in slightly alkaline solutions. It can be said for these fungi in general that they are acid-loving organisms, but such a statement does not imply that none of them will grow upon an alkaline solution. In this respect they exhibit some individual differences.

In the Richards' solution, the less favorable of the 2 major solutions used, there is no indication that any of the 8 species will grow in an alkaline culture. *Polyporus adustus* and *Pleurotus ostreatus* do grow at P_H 7.0. While this tendency to grow in a neutral solution is not as marked for *Polystictus versicolor* as for the first 2 species, it does grow better at P_H 7.0 than do the other 5. Although in some cases growth is obtained at P_H 6.8 and 6.9, *Daedalea confragosa, Lenzites sepiaria, Schizophyllum*

commune, *Pholiota adiposa*, and *Armillaria mellea* fail to grow at P_H 7.0.

This tendency to grow only in an acid medium is less evident in a more favorable nutrient, the peptone solution. Here in every case growth is secured at P_H 7.0, and only 4 species, *Polystictus versicolor*, *Lenzites sepiaria*, *Pholiota adiposa* and *Daedalea confragosa*, fail to grow in an alkaline solution. For these 4 species growth at P_H 7.0 is much less than at more acid values. Three of the remaining 4 species, *Schizophyllum commune*, *Pleurotus ostreatus*, and *Polyporus adustus*, grow definitely on a slightly alkaline solution, the first 2 growing until P_H 8.5 is reached and the third until P_H 8.0 is reached. *Armillaria mellea* in this case shows an intermediate condition similar to that obtained for *Polystictus versicolor* in the Richards' solution. While *Polyporus adustus* and *Pleurotus ostreatus* are tolerant to a neutral substratum in the Richards' solution and to an alkaline substratum in the peptone solution, this is not true for *Schizophyllum commune*, which is distinctly intolerant to neutrality in the first case and more tolerant to alkalinity than any other species in the second.

Of these fungi which were more tolerant to alkali, *Schizophyllum commune* and *Pleurotus ostreatus* are a little less tolerant to acid in the peptone solution than the other species, while *Polyporus adustus* is markedly more tolerant (table XVI). In the Richards' solution this relationship is not as distinct, for, while *Schizophyllum commune* retains indications of being less tolerant to acid, *Pleurotus ostreatus* and *Polyporus adustus* differ little or not at all from the other 5 fungi. On the other hand, of those species which show no indication of growth in alkaline solution, *Lenzites sepiaria* and *Pholiota adiposa* react as do the majority with reference to acid tolerance, while *Polystictus versicolor* shows a wider range on the acid side in the Richards' solution. *Armillaria mellea* exhibits a wider range on the acid side in the peptone solution. In other respects these 2 species do not differ from the majority.

The data obtained from these experiments have shown that mycelial growth of *Polystictus versicolor*, *Lenzites sepiaria*, *Pholiota adiposa*, *Armillaria mellea*, and *Daedalea confragosa* is

TABLE XVI

THE HYDROGEN-ION CONCENTRATION, EXPRESSED IN P_H, CAPABLE OF INHIBITING MYCELIAL GROWTH

Fungi	Solution											
	Richards'						Peptone					
	Acid limit in P_H			Alk. limit in P_H			Acid limit in P_H			Alk. limit in P_H		
	° C.			° C.			° C.			° C.		
	15	25	35	15	25	35	15	25	35	15	25	35
S. commune	3.7	3.4	3.4	7.1	6 9	7 0	3.5	2 8	2.9	8.5	8.5	8.5
L. sepiaria	3.5	3.5	3 5	7 3	7 1	6 9	2 8	2.8	3.0	7.4	7.5	7.6
Ph. adiposa	3.4	2.8	3.4	6.9	7.0	6.9	3 0	2.8	2.8	7.5	7.6	7.6
P. versicolor	3.5	2 5	3.0	7.3	7.6	6 8	2.5	2.5	3.0	7 4	7.5	7.5
Pl. ostreatus	3.3	2.9	3.5	7.5	7 2	7.5	3.5	3.0	4 2	8.5	8.5	8.5
D. confragosa	4.0	3.5	3.5	5 5	7.2	7.2	3.3	2.8	2.8	7.6	7.5	7.5
P. adustus	3.5	3.3	3.3	7.5	7.5	7.6	2.0	2 0	2 8	8.0	8.0	8.0
A. mellea	3 4	2.9	3.5	7.4	6 9	6 9	2.5	2.0	2.5	7 5	7.8	7.4

checked, or else is very poor, in alkaline solutions, and is inhibited in the acid range P_H 3.0–3.5 in the Richards' solution and 2.5–3.0 in the peptone solution. *Schizophyllum commune* and *Pleurotus ostreatus* are more tolerant to alkaline media and less tolerant to acid media, and *Polyporus adustus* is more tolerant to both alkalinity and acidity than are the above 5 species of fungi. These conclusions agree with those reached by Rumbold ('08), Spaulding ('11), Zeller ('16), and others who have observed that *Lenzites sepiaria* is extremely sensitive to traces of alkalinity. Zeller, Schmitz, and Duggar ('19) reported that *Polystictus versicolor* grew at P_H 8.6 in a Czapek's solution, changing the initial acidity to P_H 4.8. It is evident that fungi respond to wider or narrower ranges of P_H in response to various complex factors. Such a complex and interdependent set of environmental and physiological conditions control the vitality of these fungi that it is difficult to foresee just why divergent results are obtained at different times.

Without an exception the widest optimum P_H range is obtained in the more favorable medium, the peptone solution. Here, with individual variations, the optimum growth-zone is between P_H 3.5 and 6.5. In the less favorable solution, the Richards' solution, the range is more limited, being P_H 4.0–6.0. This does not imply that the optimum range always falls entirely within these limits or that growth is always equally good throughout, but

they do indicate the zones in the major portions of which the fungi show good growth. The optimum range as indicated in any 1 solution does not always foretell the range which will be obtained in any other solution, for if the one solution is more favorable for growth than the other, the range will tend to be widened, producing a curve with a slightly fluctuating optimum zone covering several P_H units.

Furthermore, the optimum range varies slightly with the temperature. A temperature too high or too low for maximum growth tends to affect the physiological balance of the fungus, resulting, no doubt, in a narrower optimum range or a range shifted a little toward either neutrality or greater acidity. Such a case is well illustrated by *Polyporus adustus* (fig. 8), *Polystictus versicolor* (fig. 14), and *Daedalea confragosa* (fig. 4). It is impossible to foretell just how a certain species will react toward a given set of conditions; therefore it is not practicable or even possible to point out any marked optimum P_H or even a narrow range of P_H in which the optimum will invariably fall.

The directions of the changes in the initial acidity due to growth vary with the solution and with the temperature. In general, growth in the Richards' solution tends to increase the acidity. However, *Polyporus adustus* decreases the acidity of this medium in the more acid range, while minor variations from this general increase are to be noted for *Pholiota adiposa* at 15° C. and 25° C. and for *Pleurotus ostreatus* at 15° C. In no case, however, are these exceptions pronounced.

This tendency toward increased acidity is not characteristic of the fungi in the peptone solution. *Lenzites sepiaria* is the only species to increase the acidity throughout the entire P_H range and at all temperatures. *Polystictus versicolor* in general also causes an increase in the acidity of this solution. On the other hand, in marked contrast to its action in the Richards' solution, *Pleurotus ostreatus* decreases the hydrogen-ion concentration in every case. For the other 5 species the results are not uniform, but on the whole the active acidity is decreased within the initial range P_H 2.5–5.5 and increased within the initial range, 6.5–8.0. P_H 6.0 in the majority of cases remains close to the initial, varying little in one direction or the other with the different fungi.

Considering the 2 major solutions, the Richards' and the peptone solution with sugar, *Lenzites sepiaria* is the most active producer of acid, the final P_H in every case being more acid than that produced for the corresponding solution by the other species (table XVII). However, in the peptone solution without sugar and in the Richards' solution with cellulose as the carbon source, this tendency toward greater final acidity is not evident. Table XII shows that in 4 out of 5 cases in the peptone sugar-free solution, the active acidity is actually decreased by *Lenzites sepiaria*.

TABLE XVII

THE AVERAGES OF THE FINAL P_H PRODUCED IN THOSE SOLUTIONS IN WHICH THE FUNGI GREW

Fungi	Solutions						
	Richards'			Peptone with sugar			Peptone without sugar
	°C.			°C.			°C.
	15	25	35	15	25	35	25
Pl. ostreatus	5.1	4.5	4.6	6.7	6.9	6.9	6.6
P. adustus	5.5	5.9	5.3	4.6	5.8	6.3	5.8
Ph. adiposa	5.1	4.3	4.6	6.0	5.5	5.9	6.1
L. sepiaria	4.6	4.2	3.9	3.5	3.3	3.5	6.1
S. commune	4.8	4.5	4.6	5.6	5.7	5.9	5.4
P. versicolor	5.1	4.4	4.6	4.8	4.7	4.7	5.4
D. confragosa	4.3	5 0	4.9	5.9	6.5	6.3	6.1
A. mellea	5.1	4 9	4.7	4.6	4 5	6.2	6.2

While *Polystictus versicolor* does not cause such a sharp acid reaction in the substratum upon which it grows, and while the results vary with the medium, this fungus does tend to increase the acidity of all the solutions. The other 6 species are less consistent than these 2 fungi toward increasing the active acidity of the major solutions. Zeller, Schmitz, and Duggar ('19), using 12 species of fungi, found in general that all except *Merulius pinastri* increased the active acidity of a potato broth-nutrient salt solution and that *Polystictus versicolor* increased the active acidity in 7 and slightly decreased it in 4 cases. It is evident that the direction of the change in the initial acidity depends upon a variety of factors.

These factors beyond a doubt are not wholly dependent upon the individual physiological action of the fungus. Undoubtedly the chemical nature and the initial acidity of the substratum

have much to do in determining whether the acidity will be increased or decreased as a result of mycelial growth. Except for *Lenzites sepiaria* and *Polystictus versicolor*, a substitution of peptone with its organic nitrogen for an inorganic nitrogen as well as a reduction in the amount of sugar tends to reduce the acid production by the fungi. Furthermore, while it is not always possible to predict the direction of the changes in acidity, it has been observed in these experiments that those solutions with a low initial acidity become more acid, and those with a high initial acidity become less acid. Temperature, on the other hand, may result in slight variations which are not possible to regulate or to express in any rule. The tendency of *Pholiota adiposa* to increase the active acidity of the peptone solutions at 15° C. and 35° C. and to decrease it at 25° C. well illustrates this point.

It is not possible to draw conclusions showing that those species tolerant to alkalinity produce a low final acidity or that those species tolerant to a more acid substratum produce a high final acidity. *Pleurotus ostreatus* does show an outstanding low final acidity in the peptone solution but not in the Richards' solution, while *Polyporus adustus* and *Schizophyllum commune* do not have a final acidity different from that for the majority of the fungi intolerant to alkalinity. *Lenzites sepiaria*, previously shown to be the most active acid producer under all conditions in the 2 major solutions, shows no tendency to grow on a solution more acid than P_H 3.0.

No one temperature can be shown to be the optimum for all the fungi under all conditions. The same temperature may not be optimum for growth under different sets of conditions. This is well illustrated by *Lenzites sepiaria*, for in the peptone solution it is impossible to indicate any one temperature as the optimum for this fungus, while in the Richards' solution it is evident that 35° C. is the best of the 3. It is more probable that there are optimum ranges of temperature rather than optimum points, and that these ranges vary with the fungi under consideration. Furthermore, these zones may overlap one another and may be widened or narrowed, depending somewhat upon the environmental and physiological factors governing growth. The

species under consideration, however, fall into 3 groups: (1) those fungi which are partial to lower temperatures, as *Schizophyllum commune* and *Polyporus adustus*, (2) those that are partial to intermediate temperatures, as *Pholiota adiposa, Polystictus versicolor*, and *Daedalea confragosa*, and (3) those that are partial to higher temperatures, as *Lenzites sepiaria, Pleurotus ostreatus*, and *Armillaria mellea.*

These temperature relations in culture can be correlated to some extent with the habitat conditions of the fungus in nature. *Schizophyllum commune*, frequently found in the early spring and late fall in shaded brush heaps, grows close to the damp soil and is surrounded by cool moist air. *Polyporus adustus*, often found in the spring and early summer months, grows most frequently on some shaded stump or log where proximity to the soil gives a moist and cool habitat. *Lenzites sepiaria*, one of the species partial to higher temperatures, grows abundantly in the southern states, making its appearance during the warm weather following the rains. For this species, Falck ('09) has found that 35° C. is the optimum. *Polystictus versicolor* is often found growing on stumps during the late spring and early fall months. Bayliss ('08) stated that 15° C. is the most favorable for this fungus, but the results obtained in this study show that there is little to choose between 15° C. and 25° C. It is evident that growth in the peptone solution is a little better at the lower temperature, but the results obtained from the Richards' solution indicate that it will grow equally well at both temperatures.

The peptone solution is by far the best of the different culture media used in these experiments. In every case the fungi show a marked partiality to the organic source of nitrogen, and, as previously mentioned, express this not only in greatly increased growth but also in widened P_H limits and in widened optimum P_H zones. The Richards' solution, on the other hand, is no better than the solution where peptone is the source of both nitrogen and carbon. With this sugar-free medium no effort was made to determine the limits of growth in respect to hydrogen-ion concentration. Consequently, it is not possible to make a sharp comparison, but it is to be noted that with 2 exceptions, *Daedalea confragosa* and *Pleurotus ostreatus*, the fungi grow in

this substratum from P_H 3.0 to 7.0. This is as wide or nearly as wide a range as secured with the majority of the species in the Richards' solution.

The diverse results obtained for the fungi in the solutions at different temperatures emphasize the fact that the wood-destroying fungi do not react alike to any one set of conditions. For this reason it is not feasible to construct a composite curve such as Meacham ('18) has done, showing a maximum, first, and second critical points, and a critical range for different species of fungi. Such a curve suggests that all fungi give the same results in any given set of environmental factors. It is not believed that this is a true assumption. Furthermore, it has been shown that different environmental conditions give different results for the same fungi. Matsumoto ('21), working with strains of *Rhizoctonia*, concluded that the hydrogen-ion concentration gave diverse results in different nutrient solutions because of the probable relations to the availability of the food materials in the different media. Therefore, since any one species of fungus does not necessarily react to a fixed set of environmental factors as would a second species, and since the same fungus reacts differently under different conditions, it is impossible to construct a composite curve representing growth for several fungi in various types of media.

These species of fungi grow to a small extent in a solution where filter-paper strips and a trace of peptone are the sources of carbon. The amount of peptone present in every case is only sufficient to start, but not to maintain, growth. This ability to utilize cellulose is lessened in the Richards' solution when no other source of carbon is provided than cellulose derived from different kinds of wood. Of all the species, *Lenzites sepiaria* and *Schizophyllum commune* are least able to utilize the cellulose in a synthetic culture. Zeller ('16) worked with *Lenzites sepiaria* and found that, on Richards', Colley's "A" and Reed's solutions, and on carrot extract with filter-paper and pine-wood celluloses as the sources of available carbon, it grew very slowly with slight hydrolysis of the pine-wood cellulose but not of the filter-paper cellulose. This distinction was not evidenced in the present cultures, for this species hydrolyzed to a small extent, in a liquid but not

in a solidified media, celluloses derived from the filter-paper and from pine, white oak, and maple woods. Poplar-wood cellulose was not used in either case.

Pleurotus ostreatus, *Polyporus adustus*, and *Armillaria mellea* are equally active in maximum growth and cellulose utilization. While the last species was grown only in culture with the filter-paper strips, its ability to utilize this form of cellulose intimates that it would utilize the celluloses in the Richards' solution as readily as the first 2 species did. The other species show intermediate use of the cellulose between the *Pleurotus ostreatus* type and the *Lenzites sepiaria* type.

It must be remembered that growth in the cellulose-nutrient solutions can not be compared favorably to growth obtained in any of the synthetic media where sugar and peptone are used. In only a few cases was growth equal to that obtained in the Richards' solution. Under the conditions of these experiments there is no doubt that sugar and peptone alone or in combination are much more effective as sources of carbon than any of the cellulose suspensions.

In view of the sensitiveness of many wood-destroying fungi toward alkalinity, it may well be asked if this principle may not be applied in wood preservation. This, of course, is a practical problem beset with many difficulties, such as the diverse conditions under which fungi grow and under which the wood is to be used. However, the inability of many fungi to grow on an alkaline substratum may be of use in the final solution of this problem. A cheap method for impregnation of freshly cut ties and other lumber with some chemical or combination of chemicals, leading to a definite and lasting alkaline reaction of the tissues, would, it is believed, be a definite step in eliminating the heavy financial losses due to the rapid decay of such timber by some species of *Agaricales* and other fungi.

Conclusions

The growth reactions of *Daedalea confragosa*, *Armillaria mellea*, *Pholiota adiposa*, *Pleurotus ostreatus*, *Polyporus adustus*, *Schizophyllum commune*, *Polystictus versicolor*, and *Lenzites sepiaria* toward different initial active acidity of synthetic,

peptone-nutrient, and cellulose-nutrient media at different temperatures have been studied. The limits of P_H, optimum P_H zone, optimum temperature, and changes in the active acidity of the solution due to growth have been determined for each of these species. In addition the utilization by these fungi of strips of filter-paper and of celluloses from white oak, pine, sugar maple, and poplar woods has been studied.

Under the conditions of these experiments it is possible to draw the following conclusions:

(1) The range of P_H in which these fungi will grow and the amount of mycelial growth depend upon the individual organism, the composition of the nutrient solution, the initial active acidity and the temperature.

(2) The major portion of the growth curves of all of these fungi is on the acid side of neutrality and in the majority of cases wholly on the acid side.

(3) In the Richards' solution the P_H which inhibit growth are: *Lenzites sepiaria*, 3.4 and 7.3; *Daedalea confragosa*, 3.5 and 7.2; *Polystictus versicolor*, 2.5 and 7.6; *Armillaria mellea*, 2.9 and 7.4; *Pholiota adiposa*, 2.8 and 7.0; *Polyporus adustus*, 3.5 and 7.6; *Pleurotus ostreatus*, 3.0 and 7.5; *Schizophyllum commune*, 3.4 and 7.0.

(4) Moreover, in the Richards' solution *Polyporus adustus*, *Schizophyllum commune*, and *Pleurotus ostreatus* grow when the medium is neutral. *Polystictus versicolor* is less tolerant to a neutral solution, while the other 4 species are inhibited by this hydrogen-ion concentration.

(5) In the peptone solution the P_H which inhibit growth are: *Polyporus adustus*, 2.0 and 8.0; *Daedalea confragosa*, 2.8 and 7.6; *Polystictus versicolor*, 2.5 and 7.5; *Armillaria mellea*, 2.0 and 7.8; *Pholiota adiposa*, 2.8 and 7.8; *Lenzites sepiaria*, 2.8 and 7.5; *Pleurotus ostreatus*, 3.0 and 8.5; and *Schizophyllum commune*, 2.8 and 8.5.

(6) In the peptone solution *Schizophyllum commune*, *Polyporus adustus*, and *Pleurotus ostreatus* grow upon a slightly alkaline solution, while the other 5 species do not.

(7) In the peptone-nutrient solution the fungi grow throughout a wider range of P_H, have a wider optimum P_H zone, and produce more felt than on the Richards' solution.

(8) With the exception of a slight decrease of the initial acidity by *Polyporus adustus* in the more acid solutions, the mycelial growth of all of these fungi increases the acidity of the Richards' solution.

(9) The active acidity of the peptone-nutrient solution is always increased by *Lenzites sepiaria* and decreased by *Pleurotus ostreatus*. The other 6 species tend, with some minor exceptions, to decrease the acidity in solutions where the initial P_H is more acid than 6.0 and to increase the acidity in solutions where the initial P_H is less acid than 6.0.

(10) All the species grow in a medium with peptone as the only source of both nitrogen and carbon. Here growth is as good or even better than in the Richards' solution where carbon is supplied in the form of cane sugar and nitrogen as NH_4NO_3.

(11) These species are capable of utilizing filter-paper strips as a source of carbon in a 0.5 per cent peptone solution: *Polystictus versicolor*, *Armillaria mellea*, and *Pleurotus ostreatus* utilize the cellulose most actively, while *Lenzites sepiaria* and *Schizophyllum commune* utilize it the least.

(12) *Lenzites sepiaria*, *Polystictus versicolor*, *Pleurotus ostreatus*, *Polyporus adustus*, and *Schizophyllum commune* make some use of white oak-, pine-, and maple-wood celluloses, when these are substituted for sugar in the Richards' solution. *Pleurotus ostreatus* and *Polyporus adustus* grow best, and *Lenzites sepiaria* the least, of the 5 species used. While *Lenzites sepiaria* is unable to use cellulose from poplar wood, the other 5 species do use it.

(13) *Polystictus versicolor*, *Pleurotus ostreatus*, *Polyporus adustus*, and *Schizophyllum commune* use these same celluloses in the Richards' solution solidified with 2 per cent agar, while *Lenzites sepiaria* fails to grow under these conditions.

(14) None of the species grow as well in a solution where cellulose is the source of carbon as where sugar and peptone are the sources.

(15) Of the 3 types of liquid media, the peptone-nutrient solution with sugar is by far the best. These fungi appear to make better use of organic forms of nitrogen than they do of the inorganic forms.

(16) It is the belief of the author that under environmental and

physiological conditions other than those in these experiments, the results as here given would be found to vary to some extent. The P_H limits, optimum P_H zone, and direction of change in the active acidity of the substratum vary with the environmental conditions.

The writer wishes to take this opportunity to express his indebtedness to Dr. B. M. Duggar for suggesting this problem and for many kindly and helpful criticisms and suggestions, and to Dr. George T. Moore for the privileges and facilities of the Missouri Botanical Garden.

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A MONOGRAPH OF THE GENUS MIMULUS[1,2]

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INTRODUCTION

An attempt to determine specimens of the genus *Mimulus* found growing in California revealed the fact that serious difficulties were to be encountered because of the scattered literature, the close relationship existing between many of the species, and the extreme polymorphism of others. In view of this, the writer decided to undertake a critical examination of the group. At first a study of only those species growing in California was contemplated, but as the work progressed and the various segregates were considered it was deemed best to make a revision of the entire genus.

This investigation was continued through a period of six years. During this time various herbaria were visited where type collections and numerous specimens were carefully studied. In addition to the large number of specimens available for critical examination at the Missouri Botanical Garden, where the major part of this work was done, material was borrowed extensively from many herbaria. For the privilege of studying these col-

[1] An investigation carried out at the Missouri Botanical Garden in the Graduate Laboratory of the Henry Shaw School of Botany of Washington University, and submitted as a thesis in partial fulfillment of the requirements for the degree of doctor of philosophy in the Henry Shaw School of Botany of Washington University.

[2] Issued January 5, 1925.

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In addition to the study of herbarium specimens, some experimental work was done. Seeds of a number of species were grown under varying conditions in the gardens and greenhouses at the University of California, Stanford University, Missouri Botanical Garden, and Cornell University. Extensive field studies were also carried on in various parts of California, especially in connection with the polymorphic groups.

History of the Genus

The genus *Mimulus* was first described by Linnaeus[1] in 'Acta Upsaliensis' in 1741. This was followed by another description

[1] Linnaeus, C., Acta Ups. 82. 1741.

and by an illustration in 'Hortus Upsaliensis,'[1] the diagnosis in each case being based on material collected in Virginia. In the first edition of Linnaeus' 'Species Plantarum,'[2] published in 1753, *M. ringens* is the only species mentioned, making it, without doubt, the type species of the genus. A full description of *Mimulus* was given in the 'Genera Plantarum,'[3] which appeared a year later. In the second edition of the 'Species Plantarum,'[4] published in 1763, the description of *M. luteus* was added, this being founded on material collected in Chile by Feuillee[5] in 1710. Within a few years, *M. aurantiacus*,[6] *M. glutinosus*,[7] and *M. alatus*[8] were described, so that in Willdenow's 'Species Plantarum,'[9] published in 1800, four species were recognized, and one, *M. aurantiacus*, was given as a synonym of *M. glutinosus*. In 1810, Robert Brown[10] published the description of a new genus which he called *Uvedalia* and to this he referred a single species, *U. linearis*, a native of Australia. This generic name, however, was soon reduced to synonymy. Several new species of *Mimulus* were subsequently recorded from time to time, but the first comprehensive treatment of the genus was made by Bentham[11] in his paper on the *Scrophulariaceae* of India. Twenty-five species were recognized, ten of which were described for the first time.

The first segregate of *Mimulus* was made by Nuttall[12] when he published the genus *Diplacus*, basing his segregation mostly on the shrubby habit and on the separation of the placentae. Four species were described as new and *M. glutinosus* Wendl. was transferred to the new genus.

Spach,[13] in 1840, proposed the second segregate, *Erythranthe*,

[1] Linnaeus, C, Hort. Ups. 1: 176, *pl. 1.* 1748.
[2] *Ibid.*, Sp. Pl. 2: 634. 1753.
[3] *Ibid.*, Gen. Pl. ed. 5, 283. 1754.
[4] *Ibid.*, Sp. Pl. ed. 2, 2: 884. 1763.
[5] Feuillee, L., Jour. 2: 745–746. 1714.
[6] Curtis, W., in Bot. Mag. *pl. 354.* 1796.
[7] Wendland, J. C., Bot. Beobacht. 51. 1798.
[8] Aiton, W., Hort. Kew. 2: 361. 1789.
[9] Willdenow, C., L. Sp. Pl. 3: 360–362. 1800.
[10] Brown, R., Prodr. 440. 1810.
[11] Bentham, G., Scroph. Ind. 27–29. 1835.
[12] Nuttall, T., in Taylor's Ann. Nat. Hist. I, 1: 137–139. 1838.
[13] Spach, E., Hist. Nat. Veg. Phan. 9: 312. 1840.

founded on a single species, *M. cardinalis* Dougl. This generic name soon accompanied *Uvedalia* into synonymy.

Bentham[1] continued his studies on the *Scrophulariaceae* and in De Candolle's 'Prodromus,' he recognized Nuttall's genus *Diplacus* and described another one which he called *Eunanus*. In all, thirty-one species were listed under *Mimulus*, four under *Diplacus*, and three under *Eunanus*, making a total of thirty-eight, eleven of which received definition for the first time.

Asa Gray[2] was the next botanist to present a systematic treatment of this genus, and in 1876 he published a synopsis of all the North American species then known. In this paper, *Diplacus* and *Eunanus* were reduced to sections, Dr. Gray believing that the intermediate forms made them invalid as genera. Twenty-nine species were included, all being grouped under four sections, *Eunanus*, *Diplacus*, *Eumimulus*, and *Mimuloides*. Bentham and Hooker[3] in the 'Genera Plantarum' followed this same treatment, and Gray,[4] later in the same year, added one more section which he called *Œnoe*.

Greene,[5] in 1885, restored *Diplacus* and *Eunanus* to generic rank, but in the following year, Dr. Gray[6] again revised the group and again reduced the segregates, saying "Polymorphus, but better retained entire under five subgenera than divided into as many genera." The same year, Greene[7] described the last segregate to be made in the genus, making *M. pilosus* (Benth.) Wats. the type species of a genus which he designated as *Mimetanthe*. The last article to be published on the group was a revision of the genus *Diplacus* by Greene,[8] who again maintained its right to generic position.

All of the most recent workers on the western flora, except Howell and Rydberg, recognize *Diplacus* and *Mimetanthe* but not *Eunanus* as valid genera. Rydberg,[9] in his 'Flora of the Rocky

[1] Bentham, G., in DC. Prodr. 10: 368–374. 1846.
[2] Gray, A., in Proc. Am. Acad. 11: 95–99. 1876.
[3] Bentham & Hooker, Gen. Pl. 2: 946–947. 1876.
[4] Gray, A., in Bot. Calif. 1: 562–569. 1876.
[5] Greene, E. L., in Bull. Calif. Acad. Sci. 1: 94–123. 1885.
[6] Gray, A., Syn. Fl. N. Am. ed. 2, 2[1]: Suppl. 442–451. 1886.
[7] Greene, E. L., in Bull. Calif. Acad. Sci. 1: 181. 1886.
[8] *Ibid.*, Pittonia 2: 151–157. 1890.
[9] Rydberg, P. A., Fl. Rocky Mountains, 777–780. 1917.

Mountains,' lists three species under *Eunanus* but the *Mimetanthe pilosa* of Greene, he places under *Mimulus* as *M. pilosus*. Wettstein[1] considers that of all the segregates, only *Mimetanthe* is entitled to generic rank and he places it in a different group.

General Morphology

Roots.—The root system in the genus *Mimulus* is not extensive, even in the shrubby forms. The majority of the species are annuals and have a simple annual root; this usually consisting of a short tap root with a few lateral ones or occasionally all of the roots are lateral. Many of the species are perennial by rooting from the nodes, and if any of the stem touches the ground roots will develop at all the joints in contact with the moist earth. Whether plants of this type are truly perennial is doubtful; in protected places they may survive the mild winters in some parts of the world, but if in an exposed position, plants of the same species are typical annuals.

Stems.—The stems vary greatly in the several groups from the dwarf subacaulescent members of *Œnoe* to those in *Diplacus* which are woody and from six to eighteen decimeters high. The majority of the perennials die down during the winter, coming up each spring so that the parts above ground are mainly annual. The stems sometimes are simple but more commonly they are more or less branched. The main axes and branches may be terete or quadrangular, terete stems being the more common. *M. ringens* and *M. alatus* have square stems, those of *M. alatus* being winged. The probable derivation of *M. alatus* from *M. ringens* is indicated by the fact that in the latter we occasionally find stems which are partly winged. In the section *Simiolus* the majority of the species have quadrangular stems, these oftentimes being hollow.

Underground stems are common in the perennial species. Most of the members of the sections *Eumimulus*, *Erythranthe*, and many of those in *Paradanthus* have horizontal stoloniferous rootstocks growing not far below the surface. A few species, such as *M. moschatus* and *M. Tilingi*, have moniliform rootstocks. *M. jungermannioides* and *M. primuloides* commonly propagate

[1] Wettstein, R., in Engler & Prantl, Nat. Pflanzenfam. 4^{3b}: 77. 1891.

themselves by scaly bulblets which appear on the underground stems toward the end of the growing season. *M. Eastwoodiae* and *M. primuloides* produce runners above ground. A few species found in Mexico and in Australia are characteristically repent.

The annual species are rarely more than three to six decimeters high as in *M. brevipes* and *M. Bolanderi.* The section *Œnoe* is peculiar in that many of the species are nearly stemless, the flowers being produced in the axils of crowded basal leaves.

Leaves.—As is the case in most polymorphic genera, *Mimulus* shows great differences in shape, texture, and size of the leaves. Throughout this genus simple leaves with little or no lobing are common. *M. laciniatus* is the only species with typically lobed or parted leaves, yet in a few of the other members of the section *Simiolus* there are small lobes at the base of the leaf-blade. The shape of the leaves within a single species in this section may vary to such an extent that descriptions of several species and a number of varieties have been wrongly based on leaf characters alone. Occasionally the leaves are mainly basal, this condition being found in *M. primuloides* and in some of the polymorphic species belonging to the section *Simiolus* as well as to *Œnoe.* The venation varies from typically feather-veined to a condition where several main veins arise from the base of the blade. The latter condition, being less common and found mostly in the more highly specialized groups, is regarded as of later derivation.

Pubescence.—There is great diversity in the kind of hairiness within the genus, viscid- or glandular-pubescence being the common type. Members of the section *Eumimulus* and many of the South American *Simioli* are typically glabrous. The single species in *Tropanthus* is glabrous but the surface is covered with sessile glands. *Diplacus* is the only group in which branched hairs have been commonly found. A few species in the section *Paradanthus* have hairs which secrete a slimy sticky substance, this latter seeming to be a late development. Most of the annuals in *Paradanthus, Eunanus,* and *Œnoe* are glandular or viscid-pubescent, and as they usually are found in dry and semi-arid places the amount of hairiness may be due to the effect of their environment.

Inflorescence.—In the majority of cases the flowers are solitary in the axils of the leaves, those in several species beginning at or near the base of the plant. In *Eumimulus* and *Simiolus* the inflorescence is usually racemose; the form of the inflorescence is of little or no value, however, in the recognition of sections in *Mimulus.* The length of the pedicels has been used by several taxonomists as a character of definite importance in separating some of the segregates of the genus, notably *Eunanus.* The relative length of the pedicel and calyx holds within the subgenus *Schizoplacus* but varies considerably within the sections in *Synplacus.* Here the pedicel may be either shorter or longer than the calyx, thus making such a character useful only in minor categories. The amount of curvature of the pedicels is helpful in specific diagnosis alone.

Calyx.—The persistent, 5-angled, more or less plicate calyx is one of the most constant characters within the genus and the most satisfactory to use in separating *Mimulus* from its nearest relatives. In a few species, such as *M. Rattani, decurtatus,* and *exiguus,* the angles are weak and the calyx almost sulcate. This would indicate close relationship to *Mimetanthe,* the only segregate of *Mimulus* which is recognized in this monograph. The calyx-teeth are conduplicate in the bud. In anthesis, they vary from almost obsolete, as in *M. Grayi,* to those from one-half to one-third the length of the tube, as in several species of *Eunanus* and *Paradanthus.* The inflated calyx common to the members of the section *Simiolus* and to some of the species in *Paradanthus* is considered to be an advanced condition.

Corolla.—The shape of the corolla shows great diversity within the genus but in general it can be relied on for broad sectional characterization. The most primitive type is probably that which we find in some of the species in the sections *Paradanthus* and *Eunanus.* Here the corolla is funnelform with an open throat and has equal or nearly equal lobes. The bilabiate and personate corollas found in the other groups are probably derived from some such condition. The tube may be included or it may be from two to four times as long as the calyx, the latter condition assuredly indicating specialization. The throat usually is exserted and may be funnelform or cylindrical. The lobes vary

greatly in shape, contour, and length, the lower lip generally being longer than the upper. There is no external evidence of nectar glands near the base of the corolla. With the exception of a few species in the sections *Eunanus* and *Diplacus*, the corolla drops off rather early, this being the chief reason for the loss in popularity of *Mimulus* as a garden flower in European countries.

The color of the corolla does not offer any satisfactory evidence as to the probable ancestry of the sections. Blue, usually considered to be the latest color to develop, is confined to *Eumimulus* and to a small group of Australian species which have been arbitrarily placed in the section *Paradanthus*. Yellow, which is supposed to be primitive, is found in all of the species in the specialized section *Simiolus* and in many of the species in *Diplacus*, *Eunanus*, and *Paradanthus*. Reddish-purple is common in *Eunanus* and *Paradanthus* and is dominant in *Œnoe*. Varying shades of scarlet appear in *Erythranthe* and the orange of many of the species of *Diplacus* becomes a deep-red in some of the members of that group. Albino forms and other color modifications are occasionally encountered and these are considered under the species where they occur. The writer feels that where color is the only factor separating two forms greater clearness is attained by making the specific diagnosis broad enough to include these anomalous conditions rather than by using special names to designate such forms.

Stamens.—The stamens are in two unequal pairs, usually equally inserted in the tube and included. The filaments are chiefly glabrous but in some species they are puberulent or pubescent. The anthers are two-celled, the cells being confluent at the apex in most of the groups but coherent for nearly half their length along the back in *Simiolus* and some of the species in *Paradanthus*. In *Simiolus* and *Eumimulus* the anthers are often connivent in the younger flowers, separating after dehiscence. A number of species have more or less hairy anthers. In *Schizoplacus* the anthers are usually brought close together, forming pairs which sometimes simulate a Greek cross.

Pistil.—The structure of the pistil conforms to that of other members of the *Scrophulariaceae* in being bicarpellary and in having a 2-celled ovary with axial placentation. The style is

usually included and may be glabrous, puberulent, or glandular-pubescent. The stigma varies from bilamellate with equal or unequal lips to peltate-funnelform. In the species with equal lips the whole inner surface is stigmatic, whereas in the other type a stigmatic condition is usually found only on the longer lip. Although in most cases the stigma is slightly above the uppermost pair of stamens, thereby facilitating cross-pollination by insects, often it is on the same level. Under the latter condition the stigma is usually self-pollinated. Self-pollination frequently happens even in normal flowers because the pollen matures at the same time as the stigma and the two are close enough together so that a slight swaying of the flower may scatter the pollen sufficiently to cause some to fall on the receptive stigma. The stigma-lips are very sensitive and close quickly when a mechanical stimulus is applied or when pollen falls on them.

Capsule.—The capsule presents much diversity of form and texture. It may be coriaceous, cartilaginous, membranaceous, or chartaceous. With the possible exception of one or two species in *Œnoe*, it is loculicidally dehiscent, opening in one of the following ways: (1) along both sutures to the base, (2) along the inner suture and only part way down the outer, (3) tardily dehiscent along the inner suture, occasionally breaking away at the base. The inclusion or exsertion of the capsule is of value only for specific definition.

The type of placentation is important, and serves as an excellent basis for separating the genus into two main groups. When the fruit matures the placentae may separate to the base, the two halves remaining adherent to the valves or they may be coherent nearly or quite to the apex, forming a firmly united central column. In *M. rubellus, Suksdorfii, deflexus,* and *montioides* there is a somewhat intermediate condition in which the placentae separate almost to the middle. The divided type of placentation seems to be more common in *Scrophulariaceae*; therefore it is here considered to be the more primitive.

Seeds.—The seeds in *Mimulus* offer little value even in the delimitation of species. They are exceedingly numerous and are usually oval or oblong with a smooth or reticulate surface. In several closely related species in *Œnoe* they are covered with curious anchor-shaped hairs.

DISCUSSION OF THE SECTIONS

In the preparation of this monograph more than seven thousand specimens of *Mimulus* have been carefully examined. As a result of this study the writer has been led to believe that the genus is most satisfactorily treated by dividing it into two subgenera with several sections under each. The species which Dr. Gray and many other systematists regarded as *Mimulus* proper or *Eumimulus* have been divided among four sections, based primarily on differences in the calyx and corolla. The members of these sections agree in having the placentae united firmly, forming a central column or separating only at the apex, rarely parting as far as the center. These sections form a subgenus, *Synplacus*. The other sections, in which the placentae divide to the base, form the second subgenus, *Schizoplacus*. Through *M. rubellus* and some of its close relatives the two subgenera intergrade, the placentae separating nearly half way to the base in these species.

Synplacus can also be distinguished by its pedicels which are usually much longer than the calyx, its glabrous or puberulent style, its bilamellate stigma with nearly equal lips, and its membranaceous capsule which is dehiscent to the base along both sutures. The species in this subgenus have been arranged in four sections, *Eumimulus*, *Erythranthe*, *Simiolus*, and *Paradanthus*.

Eumimulus was proposed as a section by Dr. Gray in his first revision of the genus in 1876. In it, he included not only the type species and its immediate allies but all of the species belonging to the subgenus under discussion. *Eumimulus* is characterized by its tubular calyx with equal teeth, its distinctly bilabiate blue corolla without the hairy palatine ridges characteristic of *Simiolus*, and its placentae which separate at the apex. One New Zealand species, *M. linearis*, varies in being an annual and in having exserted stamens. It was described by Robert Brown as the type species of the genus *Uvedalia*. However, when more material was collected the relationship between *Uvedalia* and *Mimulus* became so obvious that the newly described genus was soon relegated to synonymy.

Erythranthe as a genus was based on the single species, *M. cardinalis*, the extreme bilabiate corolla, exserted style and stamens,

and hairy anthers being the chief characters used in differentiating it. *Erythranthe* was reduced to synonymy under *Eumimulus* by Gray but later it was raised by Greene to sectional rank. The species in the section are closely affiliated and form a natural group. *M. Nelsonii* is somewhat aberrant with its unequal calyx-teeth and short style.

Simiolus was designated as a section by Greene, who expressed later the opinion that it should be raised to generic rank. In this section, he included not only the plants with personate corollas and inflated calyces but those with nearly regular corollas and prismatic calyces. As interpreted in this paper, *Simiolus* is restricted to a closely connected polymorphic group of North and South American plants. In these the mature calyx is distinctive in that it is much inflated and the lower teeth generally turn up and fold over the lateral teeth, nearly closing the orifice. The yellow corolla is personate with two prominent hairy ridges down the lower lip partly closing the throat; the stamens are included and the placentae firmly united along their entire length. The vegetative characters show more diversity than the floral ones and are of value chiefly in separating the species. This section might have been derived from *Eumimulus*, the calyx diverging in the direction of zygomorphy or it might have been developed from some member of the section *Paradanthus*. The primitive structure of the yellow-flowered *M. moschatus* of the latter section suggests a possible relationship between that species and the section *Simiolus*. It is possible that the polymorphic condition may be a relatively late development. *Simiolus* is a very plastic group, the members responding quickly to environmental changes. Consequently there has been much confusion in the delimitation of the species and the synonymy has become rather burdensome. The early horticulturists found several of these species very satisfactory to experiment with, as a result of which many interesting garden varieties were produced.

In studying the species in the sections, there was found a large number which did not seem to belong to any of the well-established groups. These mostly comprised small closely allied associations which, however, were not sufficiently distinct to warrant being placed in sections by themselves. They all have a more or

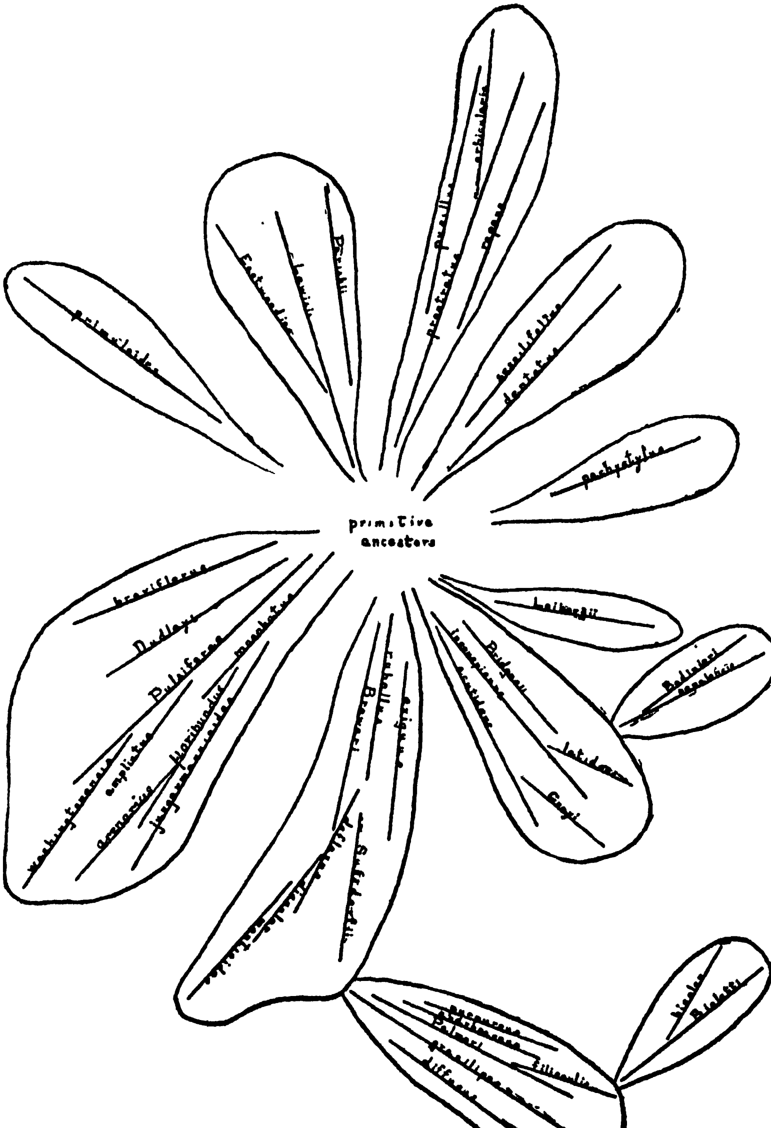

Fig. 1. Phylogenetic chart of the species in the section *Paradanthus*, showing the probable relationship within the group.

less prismatic calyx with equal or subequal teeth and the majority have corollas with funnelform throats and equal lobes. The

placentae are united into a central column separating at the apex or, in a few species, divided to the center. These points of similarity form the characteristics of *Paradanthus*, the fourth section. Possibly it will be conducive to taxonomic clearness to consider in greater detail these small groups.

Mimulus rubellus is the center of an assemblage of fairly closely related species. Nearly allied to this species is *M. Breweri*, developing parallel to *Eunanus* as shown by its general glandular-pubescence, its glandular-pubescent style, and its pedicels which are longer or shorter than the flowers. *M. Suksdorfii*, like *M. rubellus*, is almost glabrous. The two species differ only in minor details, and it is possible that *M. Suksdorfii* has been derived from *M. rubellus*. *M. deflexus* is a larger-flowered species with a reddish-purple and yellow corolla which is connected with *M. montioides* through *M. discolor*. *M. exiguus* is, at best, distantly related to this group, its weakly angled calyx setting it aside from the others.

It is possible that the six members of the *M. Palmeri* group have originated from species similar to *M. rubellus; M. gracilipes*, having the placentae divided about one-third of their length, might be an intermediate species between the two groups. *M. Palmeri* is the most widely distributed species although its diversity in color patterns suggests a recent origin. More material may show *M. filicaulis* to be only one of these color forms. *M. androsaceus* and *M. purpureus* are small plants with elongated pedicels; *M. androsaceus*, because of its less branched habit, probably being the older form. *M. Bioletti* and *M. bicolor* have been derived possibly from near *M. Palmeri*. These species agree in having distinctly corky calyx-ribs. *M. bicolor* has a bilabiate corolla, this condition being poorly developed in *M. Bioletti*.

M. nepalensis and *M. Bodinieri*, two Asiatic species closely allied to each other, suggest relationship to *M. inconspicuus* because of the inflated calyces and small corollas.

The *prostratus* alliance is composed of three species from Australia and one from India, all of which are perennials with thick, more or less succulent leaves and blue irregular corollas. *M. repens* has a personate corolla suggesting a possible evolution

along lines parallel with *Eumimulus*. With little doubt *M. pusillus* is derived from *M. prostratus*, being mostly a smaller plant with much longer pedicels. No material was seen of *M. orbicularis* and the published descriptions are not sufficiently complete to determine its relationship. It has been left with these Australian species because of its thick succulent leaves, its creeping stems, and its blue corolla.

Notwithstanding the fact that the structure of *M. Lewisii* indicates relationship to *Erythranthe*, it is not possible to include it in that section because of its nearly equal corolla-lobes and included stamens. *M. Eastwoodiae* is possibly a later offshoot of *M. Lewisii*. A resemblance to *M. cardinalis* is suggested by its densely bearded stamens and by the color of its corolla. It is noteworthy in that it is one of the few species in the genus which has developed stolons above ground. *M. Parishii* is a peculiar desert form, probably akin to *M. Lewisii*, in which the corolla has become very small, being little longer than the calyx.

M. dentatus and *M. sessilifolius* form another close alliance. *M. sessilifolius* is a native of Japan, differing from the North American *M. dentatus* mainly in having sessile leaves. It also suggests relationship to *M. nepalensis* through *M. nepalensis* var. *japonica*. The latter, however, has closer affinities with the *M. inconspicuus* group.

M. moschatus is the best-known species of an assemblage of more or less viscid-pubescent perennials or annuals with regular or irregular yellow flowers and linear or narrowly elliptical dark-green leaves. *M. moschatus, floribundus*, and *arenarius* are conspicuous because of the slimy villous hairs which are common in these species.

M. pachystylus, primuloides, and *Leibergii* show no close affiliations with one another or with other groups and may have been derived from older forms now unknown. *M. pachystylus* is one of the few species of *Mimulus* that has been collected in Chiapas, Mexico. Its bilabiate corolla, unequal calyx-teeth, and peculiarly thickened style indicate considerable advancement. *M. Leibergii* has an aspect similar to *M. acutidens* and may be related to that group. The single specimen seen, however, does not show the inflated calyces common to mature

specimens in the *M. inconspicuus* group. *M. primuloides* is unlike any of the other species because of its scapose inflorescence. It is a high mountain form common in meadows in the Rocky Mountain and Pacific Coast states.

The members of the second subgenus, *Schizoplacus*, differ from most of those in *Synplacus* not only in their separated placentae but also in their short pedicels and glandular-pubescent styles. The capsule shows considerable diversity in the different sections, varying from membranaceous to coriaceous. Except occasionally in *Eunanus*, *Diplacus*, and *Tropanthus*, it dehisces to the base only along the inner suture and part way or not at all along the outer. The species in *Schizoplacus* readily fall into six sections, *Eunanus*, *Mimulastrum*, *Œnoe*, *Pseudoenoe*, *Tropanthus*, and *Diplacus*.

Bentham proposed *Eunanus* as a genus but at Dr. Gray's suggestion he later reduced it to a section, maintaining, with good reason, that several intermediate species invalidated it as a genus. The chief reasons for raising *Eunanus* to generic rank were the divided placentae, the dehiscence of the capsule, the pubescent style, the small nearly regular corolla, and the annual habit of most of the species. From the small annuals with nearly regular corollas there is, however, a gradual transition through *M. brevipes* and *M. Bolanderi* to the large leaves and distinctly bilabiate corollas of many members of the subgenus *Synplacus*. Although the capsule, as a rule, dehisces down the inner suture and only part way down the outer, in *M. mephiticus* and *M. leptaleus* it opens to the base along both sutures, as in the species in *Synplacus*. The short pedicels and pubescent styles which have been used by some authors as of primary importance in separating *Eunanus* as a genus, are characters of doubtful generic value; besides both are found in several species in the subgenus *Synplacus*. The division of the placentae to the base is not confined to *Eunanus* but is a constant character throughout the subgenus *Schizoplacus*. It is apparent then from the weakness of these characters that *Eunanus* cannot be recognized as a genus and it has been retained, accordingly, as a section.

Mimulastrum.—This is a monotypic section based on *M. mohavensis*, differing from *Eunanus* in its very short corolla-tube,

gibbous throat and rotate corolla-lobes. It is clearly an offshoot of the section *Eunanus*, deviating in the direction of an unusual corolla.

Pseudoenoe.—The single species in the section *Pseudoenoe* is a curious desert plant, combining characters of the sections *Diplacus*, *Œnoe*, and *Mimulastrum*. Although *M. pictus* was placed in the section *Mimulastrum* by Dr. Gray, the only character to keep it there is its peculiar corolla, which is similar to that of *M. mohavensis*. The latter species has the calyx, style, and capsule of members of the section *Eunanus*, whereas *M. pictus* has a calyx more like that of *Diplacus*, and the style, stigma, and capsule of *M. Kelloggii* of the section *Œnoe*. The capsules of *M. Kelloggii* and of *M. pictus*, upon being boiled, open in the same manner as that of *Diplacus;* moreover, the rupturing of the calyx by the opening capsule and the woody base of the style which persists in *M. pictus* increases the resemblance to *Diplacus*. Without doubt the very different calyx and capsule prevent leaving *M. pictus* in the section *Mimulastrum* and equally, the peculiar corolla, unlike that of any other *Mimulus* except *M. mohavensis*, prevents putting it in the section *Œnoe*, to which most of its characters indicate relationship.

Œnoe.—The section *Œnoe* is closely related to *Eunanus*, differing in its peculiar calyx and capsule as well as in its long exserted corolla-tube. This last character, however, does not always hold true as through *M. latifolius* and *M. Congdonii* there is a gradual shortening of the corolla-tube until it approaches that of typical *Eunanus*. The capsule in all of the forms studied is very distinct, being cartilaginous, more or less woody and gibbous at the base and indehiscent or tardily dehiscent along the inner suture, often breaking away near the base. The calyx with its very unequal herbaceous teeth, differs from *Eunanus* in that it closely invests the capsule and is gibbous and scarious at the base. *Œnoe* varies from true *Diplacus* inasmuch as the calyx is rarely ruptured by the capsule and, with the exception of *M. Kelloggii*, the type of dehiscence is unlike that of the other sections.

Tropanthus.—The single species belonging to this section is represented by one specimen in the herbarium at the Missouri

Botanical Garden. It is an interesting and instructive plant, because although shrubby, with the glutinous exudation and separated placentae of *Diplacus*, it has equal acute calyx-teeth that suggest *Eumimulus*, a corolla that resembles some of the species in *Erythranthe*, and the type of capsule-dehiscence characteristic of the subgenus *Synplacus*. The calyx is peculiar inasmuch as it becomes spirally twisted over the mature capsule.

Diplacus.—The general conception of the genus *Diplacus* as stated by Nuttall and Greene was of shrubs covered with a glutinous exudation, having revolute leaf-margins and a prismatic calyx closely investing the linear-oblong capsule, the latter splitting down the inner suture, rupturing the calyx, and showing large divided placentae attached to the valves. Herbarium and field work demonstrate that the revolute character of the leaves is a variable one, some species having practically all revolute leaves and others having few or none at all. Furthermore, there is a tendency toward leaves of this kind in some of the species in the *Œnoe* and *Eunanus* sections. The dehiscence of the capsule, rupturing the closely invested calyx, was regarded as a good generic character until the same thing was found in *M. Kelloggii*, a species in every other essential belonging to the section *Œnoe*. The divided placentae, on which the genus was originally based, is characteristic also of the other sections of *Schizoplacus*. Therefore, the only constant characters left for *Diplacus* as a genus were its shrubbiness and peculiar glutinous exudation. In this connection, *M. Clevelandii*, an endemic *Mimulus* growing in San Diego Co. and Riverside Co., shows the typical glandular-villous pubescence of *Eunanus* although definitely suffrutescent. Also *M. Treleasei*, a newly described species collected by Trelease in the state of Puebla, Mexico, though shrubby and having a glutinous exudation, is not in most of its other characters related to *Diplacus*. There are then no sufficient characters for maintaining *Diplacus* as a genus.

Phylogeny

Any discussion of the phylogenetic development of this group, as of any group including a large number of closely related species, must, of necessity, be more or less hypothetical. Never-

theless, from the foregoing discussion, a probable line of descent may be surmised.

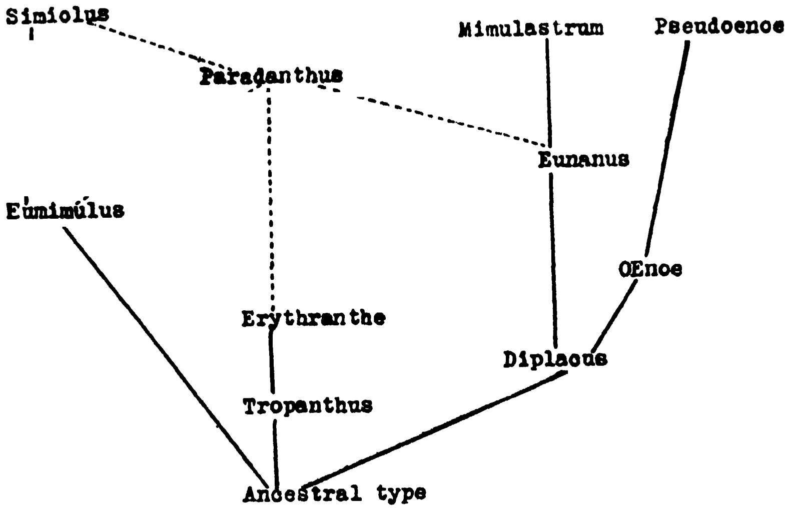

Fig. 2. Phylogenetic chart of the sections in *Mimulus*. The solid lines indicate probable direct descent. The dotted lines show the relationship of the composite group *Paradanthus* to the other sections.

There is nothing in the genus to disprove the assumption that woody plants preceded herbaceous perennials and annuals. *Tropanthus* and *Diplacus*, shrubby forms with regular or irregular calyces, divided placentae, and corollas that are irregular but not personate seem in many ways to be the most primitive of our known groups. These two sections are not closely connected and there is no indication that one preceded the other, nor necessarily that all of the sections came from either of these groups. The wide geographical distribution of *Eumimulus*, the stability of its vegetative and floral characters, and the close relationship of its two groups of species indicate that it is an ancient group; whereas the highly developed personate corolla and blue color suggest considerable advancement from the primitive condition. The regular calyx with its equal teeth might postulate derivation from *Tropanthus*, yet the localized distribution of the latter in a region far removed from any member of *Eumimulus* does not warrant this supposition. It is more likely that *Tropanthus* and *Eumimulus* are offshoots from

some ancient and nearly related ancestors which are not now known, and in the course of evolution *Eumimulus* developed its complex floral structure and herbaceous condition. *Simiolus*, with its specialized zygomorphic calyx and its closely adherent placentae, has been derived possibly from some of the North American *Eumimuli* or from some member in the section *Paradanthus*. An extreme polymorphic condition is usually regarded as a recent development and signifies that evolutionary changes are continuing. As suggested elsewhere, the wide geographic distribution of *Simiolus* may be due to the minute seed being carried in mud on the feet of migratory birds. *Erythranthe* is probably an offshoot of *Tropanthus*, as has already been asserted. *Diplacus* is the other shrubby section, and its zygomorphic calyx, irregular corolla, divided placentae, homogeneous species, and fairly wide distribution suggest a group that is somewhat ancient within this family. From it there is a gradual progression to herbaceous groups, most of which are annuals and confined to California. Within each group specialized forms may occur, each of these complex species being more or less isolated and usually growing in a much restricted area. *Pseudoenoe* with its peculiar corolla is presumably a recent offshoot of *Œnoe*. Through *M. latifolius* and *M. Congdonii* there is a progressive transition from the long slender corolla-tube of *Œnoe* to the short funnelform, campanulate, or bilabiate corolla of *Eunanus*. The species in *Eunanus* are closely related, many of them being of difficult discrimination and separated only by minor characters. Great variation and closely connected species indicate that the group is still in a process of evolution, and *Eunanus* therefore is probably of recent origin, though its corolla, in some cases, is quite primitive. *Mimulastrum* is descended from *Eunanus*, differing from it mainly in its characteristic corolla. *Paradanthus*, as stated earlier, is a collection of groups not necessarily related to one another and in all probability most of them have been derived from members of the other sections.

Geographical Distribution

The genus *Mimulus* offers very interesting problems in distribution. Of the 114 species admitted in this monograph, 74

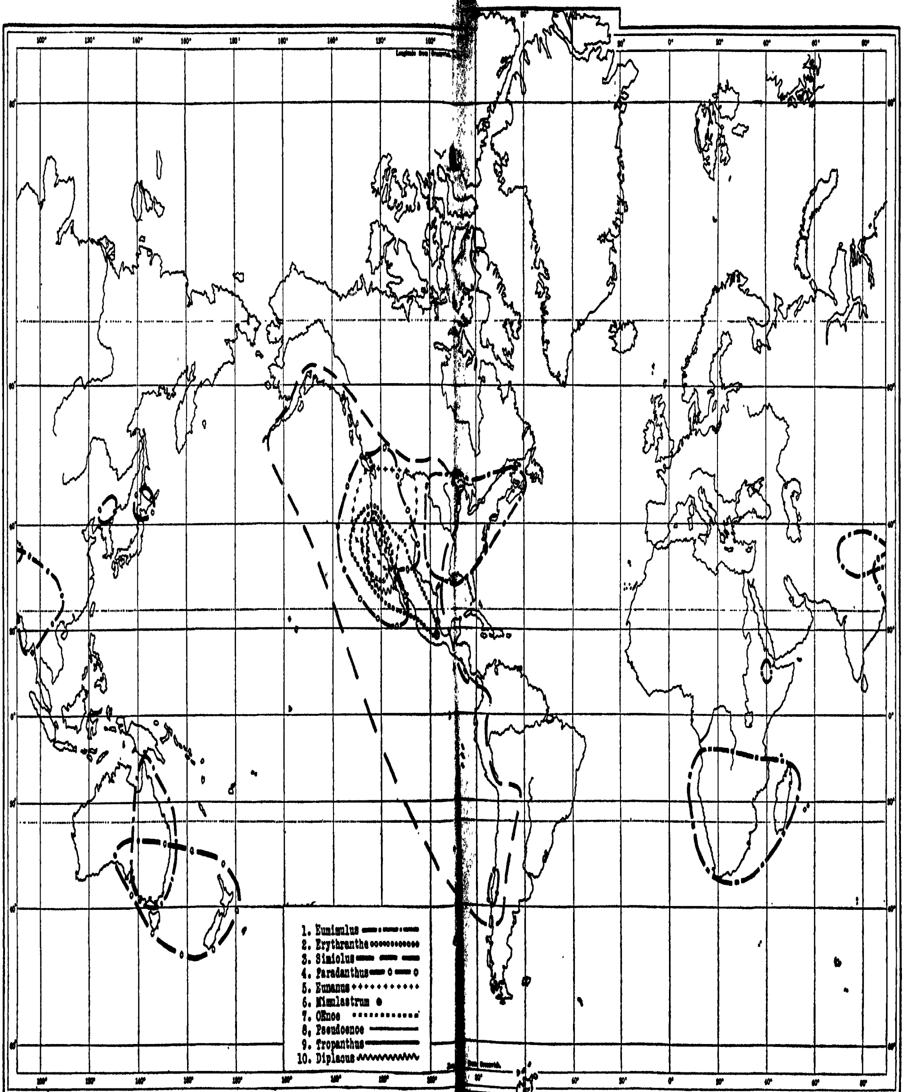

FIG. 3. MAP SHOWING THE GEOGRAPHICAL DISTRIBUTION OF THE SECTIONS IN MIMULUS.

are found in California and 51 of these have not been collected outside of the state. Besides these species native in California, 16 have been collected in western North America and 3 east of the Rocky Mountains. Of the 19 species found in Mexico, 6 are limited in their distribution to that country. In South America 8 species appear, confined almost wholly to the Pacific Coast countries. Of these, only two species have been collected outside of Chile and it is of interest that all of them, except *M. Bridgesii*, belong to the section *Simiolus*.

Mimulus is not found native in Europe nor in northwestern Africa. Three species have been reported from Asia, 2 of which are of wide distribution. *M. nepalensis* with its center of distribution in Japan is also found in China and in India, where it has given rise to one distinctive variety. *M. Bodinieri*, native only in southern China, is so closely related to *M. nepalensis* and so variable that there can be little doubt but that it is a relatively recent offshoot of that species. The structure of *M. sessilifolius*, a Japanese endemic, suggests close affinity to *M. dentatus* of the Pacific Coast states. Five species of *Mimulus* are native in Australia, of which *M. gracilis* is widely disseminated and is common in Australia, India, and southern Africa. This and the nearly allied species, *M. madagascariensis*, found on the Island of Madagascar, are the only members of the genus found in Africa.

Few of the 114 species besides *M. gracilis* and *M. nepalensis* have a wide range. *M. ringens* and *M. alatus* are common in wet places throughout the eastern part of the United States from southern Canada to Florida and west to the foothills of the Rocky Mountains. *M. glabratus* with its varieties *Fremontii* and *parviflorus* is the most widely spread of any species within the genus. The northernmost station noted is in Manitoba and it is common from there throughout the central United States, Mexico, and south into Guatemala: apparently skipping over most of Central America, it appears in Colombia, Ecuador, and Bolivia and through the variety *parviflorus* extends its range into Chile and Argentina as far south as the 44th parallel.

Although nearly three-fourths of all the species are encountered in western North America, *M. guttatus* is the only one of these having a wide distribution. It is a very polymorphic species,

common along the coast from Alaska to Mexico and inland as far as the Rocky Mountain states. It is noteworthy that the widely distributed species in *Mimulus* grow only in wet places and it is therefore probable, as Pennell[1] suggested, that birds are instrumental in the dispersal of the seeds, carrying them in mud on their feet.

In contradiction to these widely distributed members of the genus, all of the rest of the species have a more or less restricted range. The majority of the species in *Schizoplacus* are confined to California where most of them are localized in relatively small areas. *Tropanthus* is exceptional in that its only species is apparently limited to Tehuacan in southern Mexico. *Œnoe* and *Diplacus* are practically confined to California, two species in *Œnoe* and one in *Diplacus* occurring in southern Oregon and two species in *Diplacus* appearing in the northern part of Lower California. *Eumimulus* is interesting in this connection as it is the only section besides *Tropanthus* in which none of the members are found in California.

Habitat.—In habitat there is considerable diversity. Practically all of the species of *Eumimulus* and *Simiolus* grow in shallow standing water, in swamps, or along the banks of running streams and are therefore decidedly hydrophytic. The members of *Erythranthe* are usually found along the edges of stream banks. Many of the species in *Paradanthus* grow thickly in spots from which water has evaporated after standing all winter. This is also true of most of the species in *Œnoe* and for some of those in *Eunanus*. Most *Eunanus* species, however, are found in dry open sandy places, the plants often forming large patches in granite sand on exposed slopes. Several of the species commonly follow chaparral fires. *Diplacus*, one of the two shrubby groups in the genus, grows in fairly dry places and is sufficiently abundant in some situations to become a component of the chaparral. *Mimulastrum* and *Pseudoenoe* belong in hot dry regions occurring only in the desert or semi-desert areas in California. *Tropanthus* has coriaceous leaves covered with sessile glands which indicate that it grows in exposed places. Thus, within the genus, there are plants which are hydrophytic, mesophytic, or xerophytic.

[1] Pennell, in Contr. U. S. Nat. Herb. 20: 314. 1920.

Hybrids

The many intermediate forms of the section *Diplacus* found in southern California, showing all gradations in color, size, and shape of the corolla between the two common species *M. longiflorus* and *M. puniceus*, suggested that these two species must hybridize in nature. In support of this theory, the results of some work done by Dr. Loye Miller[1] when a graduate student at the University of California are of particular interest. Dr. Miller crossed a plant of *M. longiflorus* from near Los Angeles with a plant of *M. puniceus* from near San Diego. With *M. puniceus* as the female parent, the cross was successful; the reciprocal cross, however, gave no results. In plants of the first generation were combined characters of both parents, as would be expected. The flowers were salmon-colored with the long-tubed large corollas of *M. longiflorus* and the intermediate type of pubescence between the parents. The plants produced little pollen so that it was difficult to get seed from self-pollinated flowers. Nevertheless, some were obtained and plants of the F_2 generation showed red, yellow, and salmon flowers, the salmon ones being the most abundant. Specimens were collected from these plants which were growing in the botanical gardens at the University of California in 1918. These were later compared with a large series of plants of intermediate color forms chiefly collected by Dr. P. A. Munz, Ivan Johnston, and Robert Harwood, of Pomona College, in the foothills between Los Angeles and San Diego. These plants could readily be separated into four groups, according to the color, shape, and size of the corolla, the length and shape of the calyx, and the presence or absence of hairs on the calyx. Members of two of these groups corresponded very closely with the specimens of the experimentally produced hybrids. In view of this it is probable that further work would yield plants corresponding to the other groups. Typical *M. longiflorus* is found from Santa Barbara Co. to southern Los Angeles Co., rarely as far as Lower California. From Los Angeles Co. southward, it extends into the district where *M.*

[1] The interesting results of the experimental study outlined above were sent to the writer by Dr. Miller. They have not been previously published because the work was not completed.

puniceus is found, and it is in this overlapping area that most of the intermediates have been collected.

In the middle of the nineteenth century, European gardeners secured several hybrid species by crossing *M. aurantiacus* and *M. puniceus*. These two parents do not have the same natural geographical range, *M. aurantiacus* being confined to the foothills in California north of Santa Barbara Co. and *M. puniceus* occurring south of Los Angeles, with its center of distribution near San Diego. Therefore, hybrids between them would not be looked for except in gardens.

Economic Uses

Mimulus has little value from an economic standpoint except in furnishing some easily cultivated ornamental plants. On account of the crisp leaves and agreeable taste, *M. luteus* and *M. glabratus* are cooked as greens or in soup or eaten as a salad by the natives in many parts of South America. It is locally called "placa" or "la polcura." Hieronymus says that in Argentina the leaves of *M. parviflorus* are considered an excellent remedy for liver trouble.

Abbreviations

Abbreviations indicating the herbaria where specimens cited in this monograph are deposited are as follows:

Calif.	= University of California Herbarium
Calif. Acad.	= California Academy of Sciences Herbarium
Cornell	= Cornell University Herbarium
Davidson	= A. Davidson Herbarium
Deam	= C. C. Deam Herbarium
Drushel	= J. A. Drushel Herbarium
Epling	= Carl Epling Herbarium
F	= Field Museum of Natural History Herbarium
G	= Gray Herbarium
Greene	= E. L. Greene Herbarium
K	= Kew Herbarium
M	= Missouri Botanical Garden Herbarium
N. Y.	= New York Botanical Garden Herbarium
Ore.	= Oregon Agricultural College Herbarium

Phil.	=	Philadelphia Academy of Natural Sciences Herbarium.
Pomona	=	Pomona College Herbarium
R. Mt.	=	Rocky Mountain Herbarium
Stanford	=	Stanford University Herbarium
U. S.	=	United States National Herbarium
Wellesley	=	Wellesley College Herbarium

TAXONOMY

Mimulus L. Sp. Pl. **2**: 634. 1753, and ed. 2, **2**: 884. 1763; Gen. Pl. ed. 5, 283. 1754; Adans. Fam. Pl. **2**: 211. 1763; Willd. Sp. Pl. **3**: 360. 1800; Nutt. Gen. **2**: 50. 1818; Benth. Scroph. Ind. 27. 1835; DC. Prodr. **10**: 368. 1846; Endl. Gen. 681. 1836–40; Hook. Fl. Bor. Am. **2**: 99. 1840; Steudel, Nom. 534. 1821, and ed. 2, 150. 1841; Pfeiffer, Nom. Bot. **2**¹: 320. 1874; Gray in Proc. Am. Acad. **11**: 95. 1876, excl. section *Mimuloides;* Syn. Fl. N. Am. **2**¹: 273. 1878, ed. 2, and Suppl. 442. 1886, excl. section *Mimuloides;* Benth. & Hook. f. Gen. Pl. **2**: 946. 1876, excl. section *Mimuloides;* Greene in Bull. Calif. Acad. Sci. **1**: 106. 1885, excl. section *Mimuloides;* Curran in Proc. Calif. Acad. Sci. II. **1**: 258. 1888, excl. *M. pilosus;* Baillon, Hist. Pl. **9**: 450. 1888; Durand, Gen. Phaner. 294. 1888, excl. section *Mimuloides;* Wettst. in Engl. & Prantl, Nat. Pflanzenfam. **4**³ᵇ: 71. 1891; Dalla Torre & Harms, Gen. Siph. 457. 1900–1907; Pennell in Torreya **19**: 147. 1919.

Cynorrhynchium Mitch. in Acta Acad. Nat. Cur. **8**: App. 207. 1748.

Monavia Adans. Fam. Pl. **2**: 211. 1763.

Uvedalia R. Br. Prodr. 440. 1810, and 124. 1821; G. Don, Hist. Dichlam. Pl. **4**: 555. 1838.

Erythranthe Spach, Hist. Nat. Veg. Phaner. **9**: 312. 1840.

Diplacus Nutt. Ann. Nat. Hist. I. **1**: 137. 1838; Curtis, Bot. Mag. II. **12**: *pl. 3655.* 1838; Greene in Bull. Calif. Acad. Sci. **1**: 94. 1885; Pittonia **2**: 151. 1890.

Eunanus Benth. in DC. Prodr. **10**: 374. 1846; Greene in Bull. Calif. Acad. Sci. **1**: 96. 1885.

Annuals, herbaceous perennials, or shrubs, glabrous, viscid or glandular-pubescent, pilose or slimy-viscid. Leaves opposite,

sessile or petioled, simple, entire, toothed or sometimes lobed, the upper commonly much reduced. Flowers solitary, axillary, or terminal, often disposed in open racemes. Calyx tubular or campanulate, 5-angled, 5-toothed, mostly plicate, persistent and often accrescent; teeth equal or unequal. Corolla bilabiate or equally lobed, blue, red, reddish-purple, yellow or rarely white; tube cylindrical or funnelform, included or exserted, expanding gradually or abruptly into a long or short throat;[1] upper lip exterior in the bud, 2-lobed, erect or spreading; lower lip mostly longer, 3-lobed, spreading and usually with 2 hairy protuberances or patches in the throat. Stamens 4, with no indications of a fifth, didynamous, included or exserted; filaments mostly glabrous, more or less adnate to the lower part of the corolla; anthers 2-celled, confluent at the apex, base more or less divaricate. Pistil bicarpellary; ovary 2-celled; style glabrous or pubescent, commonly longer than the stamens, included or exserted; stigma bilamellate or peltate-funnelform, lobes equal or unequal. Capsule oblong or linear, 2-valved, often sulcate, membranaceous to cartilaginous, loculicidally dehiscent, rarely indehiscent; placentae separating and the halves adherent to the valves or united and forming a central column. Seeds small, numerous, oval, smooth or reticulate.

Type species: *M. ringens* L. Sp. Pl. 634. 1753.

Synopsis of the Subgenera and Sections

Subgenus I. Synplacus Grant. Placentae completely united into a central column or parting less than half way to the base; pedicels usually longer than the calyx; style glabrous or puberulent, rarely pubescent; capsule mostly dehiscent to the base along both sutures.

A. Calyx-teeth equal or subequal.
  a. Corolla-lobes distinctly unequal.
    α. Corolla-throat nearly closed by the prominent palate.... § 1. *Eumimulus*
    β. Corolla-throat broad and more or less open.
      I. Calyx-teeth 4–6 mm. long........................ § 2. *Erythranthe*
      II. Calyx-teeth less than 3 mm. long.............. § 3. *Paradanthus*
  b. Corolla-lobes equal or subequal........................ § 3. *Paradanthus*

[1] The term "throat" is used throughout this monograph with the meaning expressed by Dr. Gray in his 'Structural Botany'—"The orifice of a gamopetalous corolla or calyx, including any portion between this and the proper tube."

B. Calyx-teeth unequal, the posterior tooth larger than the others.
   a. Lower teeth of mature capsule folding over the lateral and upper tooth; corolla yellow.................................§ 4. *Simiolus*
   b. Lower teeth of mature capsule not folding over the lateral and upper tooth; corolla red.................................§ 2. *Erythranthe*

Subgenus II. SCHIZOPLACUS Grant. Placentae mostly separating to the base and adherent to the valves; pedicels usually shorter than the calyx; style glandular-pubescent; capsule mostly dehiscent to the base along the inner suture and part way or not at all along the outer.

A. Herbaceous plants.
   a. Capsule membranaceous, not gibbous nor oblique at the base.
      α. Corolla tubular-funnelform to nearly campanulate; style glandular-pubescent along the upper half.......................§ 5. *Eunanus*
      β. Corolla salverform, lobes rotate; style pubescent along its entire length..§ 6. *Mimulastrum*
   b. Capsule cartilaginous, gibbous or oblique at the base.
      α. Corolla-tube much exserted, lobes erect or spreading.......§ 7. *Œnoe*
      β. Corolla-tube included, lobes rotately spreading........§ 8. *Pseudoenoe*
B. Shrubs or suffrutescent plants.
   a. Mature calyx twisted over the capsule, teeth equal......§ 9. *Tropanthus*
   b. Mature calyx not twisted, teeth unequal................§ 10. *Diplacus*

SUBGENUS I. SYNPLACUS Grant

Subgenus I. SYNPLACUS Grant, new subgenus.

Perennial or annual herbs, slimy-viscid, glandular-pubescent or glabrous; pedicels mostly longer than the calyx; corolla bilabiate or with equal or subequal lobes; stamens included or exserted, glabrous or pubescent; style glabrous or occasionally puberulent or glandular; stigma bilamellate, usually with equal lips; capsule membranaceous, shorter than the persistent calyx, mostly dehiscent to the base along both sutures; placentae completely united in a central column or separating at the apex, rarely divided to the middle. Sect. 1–4.

SECTION 1. EUMIMULUS Gray

§1. EUMIMULUS Gray in Proc. Am. Acad. 11: 97. 1876, as to *M. ringens* and *M. alatus*; Syn. Fl. N. Am. 2^1: 276. 1878, ed. 2, and Suppl. 446. 1886, as to *M. ringens* and *M. alatus* only; Greene in Bull. Calif. Acad. Sci. 1: 107. 1885; Wettst. in Engl. & Prantl, Nat. Pflanzenfam. 4^{3b}: 72. 1891, as to *M. ringens* and *M. alatus*; Dalla Torre & Harms, Gen. Siph. 457. 1900–1907.

Herbaceous plants; stems quadrangular, mostly glabrous; leaves dark green, not viscid nor slimy, 1-nerved or pinnately veined; inflorescence racemose; calyx prismatic, sharply angled, little or not at all inflated when mature, teeth equal; corolla personate, blue, varying to white in some specimens; anthers and style glabrous, stigma-lips equal; capsule membranaceous, about as long as the calyx, dehiscent to the base along both sutures, the placentae separating at the apex. Sp. 1–5.

Key to the Species

A. Leaves pinnately veined.
  a. Leaves mostly sessile; pedicels more than one-half as long as the leaves .... *1. M. ringens*
  b. Leaves petioled; pedicels mostly less than one-half as long as the leaves .... *2. M. alatus*

B. Leaves not pinnately veined.
  a. Leaves 1-nerved.
    α. Stamens included .... *3. M. gracilis*
    β. Stamens exserted .... *5. M. linearis*
  b. Leaves 3-nerved .... *4. M. madagascariensis*

1. **M. ringens** L. Sp. Pl. 634. 1753; Walter, Fl. Caroliniana, 172. 1788; Curtis, Bot. Mag. I. **8**: *pl. 283.* 1794; Willd. Sp. Pl. **3**: 360. 1800; Michx. Fl. Bor. Am. **2**: 23. 1803; Persoon, Syn. Pl. **2**: 163. 1807; Pursh, Fl. Am. Sept. **2**: 426. 1814; Nuttall, Gen. **2**: 51. 1818; Lodd. Bot. Cab. **5**: *pl. 410.* 1820; Elliot, Bot. S. Carolina & Ga. **2**: 124. 1824; Torrey, Comp. Fl. North. & Middle States, 242. 1826; Nat. Hist. N. Y. **2**: 36. 1843; Hook. Fl. Bor. Am. **2**: 100. 1840; Benth. Scroph. Ind. 28. 1835; DC. Prodr. **10**: 369. 1846; Gray, Manual, 299. 1848; Proc. Am. Acad. **11**: 98. 1876; Syn. Fl. N. Am. **2**[1]: 276. 1878, ed. 2, and Suppl. 446. 1886; Greene in Bull. Calif. Acad. Sci. **1**: 107. 1885; Coulter, Contr. U. S. Nat. Herb. **2**: 309. 1892; Robinson & Fernald in Gray, Manual, ed. 7, 723. 1908; Britton & Brown, Ill. Fl. **3**: 157, *fig. 3265.* 1898, and ed. 2, **3**: 190, *fig. 3775.* 1913; Britton, Manual, 827. 1901, and ed. 2, 1905; Small, Fl. Southeastern U. S. 1062. 1903, and ed. 2, 1062. 1913; Pennell in Torreya **19**: 148. 1919.

M. pallidus Salis. Prodr. 99. 1796.

M. acutangulus Greene, Leafl. Bot. Obs. & Crit. **2**: 1. 1909.

M. ringens var. *congesta* Farwell, Rept. Mich. Acad. Sci. **19**: 249. 1917.

M. ringens f. *Peckii* House in Bull. N. Y. State Mus. **1921**: 17. 1923.

Perennial by stoloniferous rootstocks, produced late in the season, the whole plant glabrous; stem 4–13 dm. high, simple or branched, 4-angled, the angles sometimes slightly winged; leaves thin, oblong or oblong-lanceolate, 2.5–10 cm. long, .5–3 cm. wide, acute or obtuse, serrate, rarely entire, tapering to a broad, often auriculate-clasping sessile base, or rarely some of the leaves with a short, broad-margined petiole, occasionally with smaller leaves fascicled in the axils; pedicels stout, 2–3.5 cm. long, mostly shorter than the subtending leaves; calyx tubular, becoming broadly oblong in fruit, 1.4–1.7 cm. long, strongly angled, teeth slender, subulate or aristate, about one-fourth as long as the tube, sinuses broad, ciliate; corolla 2.5–3.5 cm. long, blue, rarely pink or white, tube exserted, slightly funnelform, throat nearly closed, upper lip erect, strongly reflexed, lower lip longer and spreading, the margins often erose; upper pair of stamens slightly exserted; style exserted, stigma bilamellate, with broad, rounded, equal lips; capsule included, broadly oblong; seeds oblong, papillate.

Distribution: common in wet places from Canada to Florida, west to North Dakota, and south to Texas.

Specimens examined:

Ontario: Ashdod, 24 July, 1893, *Fowler* (M); Farm Point, Gatineau River, Quebec, 20 Aug., 1911, *Macoun 80935* (Cornell); wet places, Lincoln Co., 29 July, 1897, *McCalla 457* (Cornell).

Maine: river intervale, Orono, Penobscot Co., 29 July, 1895, *Fernald 364* (M).

New Hampshire: Hanover, 15 July, 1910, *Barss* (Ore.); Laconia, 1892, *Carter* (Cornell).

Vermont: Barnet, Caledonia Co., 28 July, 1884, *Blanchard* (M).

Massachusetts: between South Sudbury and Framingham, 2 Aug., 1903, *Greenman 2112* (M); brookside, Granville, 20 Sept., 1913, *Seymour 25* (M); meadows, Scituate, 19 Aug., 1870, *Morong 66* (M); border of stream, Adams, 24 Aug., 1901, *Day 9* (R. Mt.).

Connecticut: Middletown, Sept., 1835, *Buckley* (M).

New York: Keene Valley, Essex Co., 1 Aug., 1891, *Schrenk* (M);

in uliginosis, Gouverneur, 22 July, 1873, *Redfield 6121* (M); Fleishmann's, Delaware Co., 30 July, 1892, *Schrenk* (M); frequent in swamps and along springs, Chemung Co., 20 July, 1893, *Lucy 154* (R. Mt.); Van Rensselaer Swamp, Rensselaer Co., 27 July, 1903, *Cipperly* (Cornell); marsh, Ithaca, 17 June, 1878, *Trelease* (M); Renwick Flats, Ithaca, 12 July, 1916, *Munz 328* (Pomona); Keep Woods, east of Lockport, 17 July, 1895, *Townsend* (Cornell); River Flats, Truxton, 5 July, 1894, *Wiegand* (Cornell); Syracuse, July, 1889, *Overacker* (Cornell).

New Jersey: moist shaded place, Greenwood Lake, Passaic Co., 11 Aug., 1907, *Mackenzie 2837* (M); Peakack, July, 1886, *Perry* (M).

Pennsylvania: West Manchester, 10 Aug., 1898, *Eisenhower* (M); swamps, Lower Merion, 19 Aug., 1874, *Redfield 6128* (M); Susquehanna, July, 1889, *A. F. Eby* (M); Pequea, July, 1889, *J. H. Eby* (M); Dillerville, 1888, *J. H. Eby* (M); Meadville, Aug., 1893, *C. D. Curtis 68* (Pomona).

Maryland: Mill Creek, 25 July, 1902, *Shull 103* (M).

District of Columbia: moist places, 3 Aug., 1892, *Blanchard* (M); low and swampy clay, 26 or 27 July, 1893, *Boettcher 245* (M and R. Mt.).

West Virginia: near Bucklin, 5 Aug., 1895, *Pollock* (M).

North Carolina: moist soil, Biltmore, 3 Aug. (flower), 30 Sept., 1897 (fruit), *Biltmore Herb. 638b* (M); side of Tryon Mts., 20 July, 1899, *Townsend* (Cornell).

South Carolina: Whitmer Park, *Anderson*, 4 Aug., 1917, *Davis* (Stanford).

Georgia: Georgia, 1833, *Beyrich* (M).

Alabama: Auburn, Lee Co., 8 Aug., 1897, *Earle & Baker* (M and R. Mt.).

Ohio: rich moist sandy soil, Berlin Heights, Erie Co., 31 July, 1914, *MacDaniels 137* (Cornell); Rocky River near Cleveland, 1892, *Greenman 1528* (M); Drushel Farm, Holmes Co., 25 July, 1913, *Drushel 888* (M and Drushel); in wet places near Canton, without date, *Riehl 41* (M); morasses, Canton, Aug., 1835, *Riehl* (M); ditch, Bowling Green, 19 Aug., 1919, *Moseley* (M).

Tennessee: Carroll Co., 5 Aug., 1897, *Eggert* (M); swamps, Knox

Co., 18 June, 1898, *Ruth 569* (M); damp soil, Fountain City, 22 July, 1904, *Ruth 106* (M); wet places, Knoxville, Sept., 1895, *Ruth* (Pomona).

Kentucky: near Poor Fork Post Office, Harlan Co., Aug., 1893, *Kearney 225* (M).

Illinois: Chicago, 20 Aug., 1893, *Glatfelter 328* (M); River Forest, Cook Co., 15 July, 1896, *Chase* (M); Cahokia, 30 July, 1878, *Eggert* (M and R. Mt.); wet places, St. Clair Co., 26 July, 1877, *Eggert* (M); Chicago, 13 Aug., 1892, *Moffatt 1652* (R. Mt.); swampy ground, Peoria, July, 1900, *McDonald* (R. Mt.).

Indiana: low borders of swale, Blackford Co., 16 July, 1905, *Deam 58* (M); in marsh near Culver, near Lake Maxinkuckee, 25 July, 1900, *Scovell & Clark 1193* (Stanford).

Iowa: Ames, without date, *Hitchcock* (M); Ames, 1892, *Carver* (M); wet places, Decatur Co., 17 Sept., 1904, *Anderson* (M and R. Mt.); Des Moines, 18 Sept., 1895, *Carver* (M); wet prairies, Armstrong, Emmet Co., 1884, *Cratty* (Stanford); wet soil, Allamakee Co., 28 June, 1895, *Fitzpatrick & Fitzpatrick* (R. Mt.).

Michigan: in ditch, Ingleside, Cheboygan Co., 28 July, 1917, *Gates & Gates 10660* (M); Mich. Agr. Coll., 14 July, 1888, *Lake* (Ore.); wet places, St. Joseph, 14 July, 1903, *Mell* (R. Mt.).

Wisconsin: Madison, 22 July, 1889, *Trelease* (M).

North Dakota: Lisbon, 4 July, 1898, *Fieldstad* (R. Mt.).

South Dakota: creeks, Brookings, 10 July, 1893, *Thornber* (M); Brookings, 1892, *Williams* (R. Mt.).

Missouri: Venice, 16 Aug., 1885, *Wislizenus 265* (M); East Carondelet, 17 July, 1890, *Hitchcock* (M); margin of lakes in American bottoms, Aug., 1841, *Engelmann* (M); Jefferson Barracks, 11 Sept., 1886, *Pammel* (M); low wet places, common along all the little streams, Jackson Co., 14 July, 1889, *Bush 1047* (M); frequent in low grounds, Harlem, 23 July, 1899, *Mackenzie* (M); West Hannibal, 17 July, 1913, *Davis 129* (M); Webb City, 25 Sept., 1908, *E. J. Palmer 1481* (M); wet places, Montier, 23 Oct., 1908, *Bush 5320* (M); low ground, Courtney, 4 Oct., 1917, *Bush 8246* (M).

Oklahoma: Cleveland Co., 7 Aug., 1900, *White 80* (M. and R. Mt.).

Kansas: moist places, Riley Co., Aug., 1897, *Pond 1082* (M); Manhattan, 31 Aug., 1892, *Norton* (M).

Nebraska: Lincoln, Aug., 1888, *Webber* (M); Red Bird Creek, 26 July, 1893, *Clements 2786* (Cornell).

Minnesota: Minnetonka, Oct., 1886, *Davidson* (Pomona); Nicollet, July, 1892, *Ballard* (R. Mt.); Portage, 18 July, 1891, *Woods* (R. Mt.).

M. ringens is one of the common species in the genus and can be distinguished by its blue personate corolla, its long pedicels, and its usually sessile leaves.

1a. Var. **minthodes** (Greene) Grant, comb. nov.

M. minthodes Greene, Leafl. Bot. Obs. & Crit. **2**: 1. 1909.

Leaves elliptical, acute at each end and often short-petioled.

Distribution: southeastern United States.

Specimens examined:

Georgia: wet meadow, Lafayette, 925 ft. alt., 2 Aug., 1900, *Harper 342* (N. Y.).

Maryland: Front Pike, College Park, 3 Oct., 1900, *Pond* (M).

The variety merges into the species through such specimens as *Seymour 25* from Massachusetts, *Shull 103* from Maryland, and *Blanchard's* specimen from Washington, D. C. In this last specimen some of the leaves are short-petioled or sessile by a narrow base and the others are broad and auriculate-clasping. *Boettcher 245* from Washington, D. C., has both clasping and short-petioled leaves on the same plant and the upper part of the stem is winged. Overacker's specimens from Syracuse, N. Y., and Lake's specimens from the Michigan Agricultural College show winged stems also. As is usual with blue-flowered plants, occasional plants are found with white or pale pink corollas. Examples of these are to be found in the following specimens collected in New York: Ithaca, 20 July, 1878, *Dudley* (Cornell); damp soil along Glenwood Road, Ithaca, 19 Aug., 1913, *E. L. Palmer 1089* (Cornell); West Marsh, Ithaca, 19 Aug., 1913, *E. L. Palmer 1084* (Cornell).

2. **M. alatus** Ait. Hort. Kew. **2**: 361. 1789; Willd. Sp. Pl. **3**: 361. 1800; Pursh, Fl. Am. Sept. **2**: 426. 1814; Bart. Fl. N. Am. **3**: *pl. 94*. 1823; Sprengl. Syst. Veg. ed. 16, **2**: 799. 1825; Walp. Rep. **3**: 275. 1844–45; Lodd. Bot. Cab. *pl. 410*. 1820;

Benth. Scroph. Ind. 28. 1835; DC. Prodr. **10**: 369. 1846; Gray in Proc. Am. Acad. **11**: 98. 1876; Syn. Fl. N. Am. **2**¹: 276. 1878, and ed. 2, 1886; Greene in Bull. Calif. Acad. Sci. **1**: 107. 1885; Coulter, Contr. U. S. Nat. Herb. **2**: 309. 1892; Britton & Brown, Ill. Fl. **3**: 158. *fig. 3266.* 1898, and ed. 2, **3**: 190. *fig. 3776.* 1913; Britton, Manual, 827. 1901; Small, Fl. Southeastern U. S. 1063. 1903; Robinson & Fernald in Gray, Manual, ed. 7, 723. 1908; Pennell in Torreya **19**: 148. 1919.

M. alatus f. *albiflorus* House in Bull. N. Y. State Mus. **1921**: 17. 1923.

Stems stoloniferous, glabrous, 2–7 dm. high, simple or branched, 4-angled, the angles more or less winged; leaves broadly ovate to ovate-lanceolate, acute, 5–15 cm. long, 2–6 cm. high, serrate, tapering to a narrow margined petiole, 1–1.5 cm. long; pedicels stout, mostly shorter than the calyx; calyx oblong, 1.4–1.7 cm. long, angles sharp, teeth 1.5 mm. long, broad, mucronate; corolla blue or violet, sometimes tinged with pink, rarely white, 2–2.5 cm. long, tube slightly exserted, throat nearly closed, lobes of the upper lip erect, strongly reflexed, the lower lip longer and spreading; stamens and style included; capsule ovate, obtuse; seeds oval, papillate.

Distribution: common in the Atlantic states from Massachusetts to South Carolina, west to the Mississippi River and south to Texas.

Specimens examined:

Massachusetts: Cambridge, 26 July, 1875, *Bailey* (Stanford).

Pennsylvania: Northampton Co., 1878, *Raw 47* (M); Conewago Mts., July, 1898, *Eisenhower* (M); Smithville, Lancaster Co., 3 Sept., 1892, *Heller & Halbach 633* (Cornell and M); Pittsburgh, 1831, *Volz* (M); low woods along Trout Run, Wawa, Delaware Co., 29 July, 1904, *Painter 816* (M); Dillerville, Aug., 1889, *A. F. Eby* (M); Safe Harbor, July, 1889, *A. F. Eby* (M).

New Jersey: Bloomfield, July, 1877, *Rusby* (Cornell).

District of Columbia: low ground, 31 July, 1896, *Steele* (M); along shaded streams, Anacostia, 24 July, 1904, *Painter 760* (M).

Virginia: along Hunting Creek near Alexandria, 12 Aug., 1902, *Shull 206* (M); Fairfax Co., Aug., 1865, *A. H. Curtis* (Cornell).

South Carolina: Batesburg, 20 Aug., 1913, *McGregor 223* (Stanford).

West Virginia: near Bucklin, 8 Aug., 1894, *Pollock* (M, R. Mt., and Cornell)

Tennessee: low wet grounds, Knoxville, 18 June, 1898, *Ruth 568* (M); wet places, Knoxville, Sept., 1895, *Ruth* (R. Mt.).

Kentucky: Bowling Green, 20 Sept., 1894, *Price* (M); South Hills, 3 miles south of Louisville, 19 Aug., 1892, *Bergman* (Cornell); low muddy river banks, Wickliffe, Ballard Co., 25 Sept., 1919, *E. J. Palmer 16582* (M).

Ohio: Berea, 3 Aug., 1895, *Ashcroft* (Pomona); Berea, July, 1896, *Ashcroft* (M); Perkisis, Erie Co., 11 Aug., 1894, *Moseley* (M); dry creek bed, Beechwood Camp, 7 Aug., 1910, *Overholts* (M); Burnet Woods, Cincinnati, June, 1875, *James* (Stanford).

Indiana: in low woods, Wells Co., 3 Aug., 1905, *Deam 133* (M): damp ravine in woods in Robinson Park, Allen Co., 19 Aug., 1906, *Deam 1577* (Deam); in low woods near Chestnut Ridge, Jackson Co., 11 Aug., 1911, *Deam 9507* (Deam).

Illinois: wet places, Prairie du Pont, 3 Aug., 1875, *Eggert* (M); Cahokia, 30 July, 1878, *Eggert* (M and R. Mt.); Millstadt Junction, 9 Sept., 1891, *Douglas* (M); Cahokia, 13 Aug., 1890, *Hitchcock* (M); Springfield, 31 July, 1892, *Dewart 26* (M); St. François River, Dunklin Co., 20 Aug., 1897, *Trelease 514* (M); Gascondy, 21 July, 1914, *Emig 235* (M); Tunnell Hill, Johnson Co., 4 Oct., 1919, *E. J. Palmer 16685* (M).

Missouri: Jackson Co., 3 Aug., 1893, *Bush* (M); Neeleyville, 8 Aug., 1894, *Eggert* (M); Jerome, 30 Aug., 1913, *Kellogg 133* (M); Forest Park, St. Louis, 30 Aug., 1878, *Eggert* (M); near Suspension Bridge, Forest Park, St. Louis, 6 Sept., 1889, *Trelease* (M); along branches of creeks, Greenwood, 28 Oct., 1915, *Bush 2911* (M); Wayne City, 28 Sept., 1895, *Mackenzie 295* (M); Raytown, 7 Aug., 1895, *Mackenzie 292* (M); Kansas City, 24 July, 1895, *Mackenzie 289* (M); Poplar Bluff, 7 Aug., 1892, *Dewart 7* (M); low ground, Oakwood, 6 Aug., 1914, *Davis 3342* (M); wet places, Noel, 13 Oct., 1908, *Bush 5283* (M); Noel, McDonald Co., 1 Sept., 1913, *E. J. Palmer 4044* (M); Webb City, Jasper Co., 20 Aug., 1906, *E. J. Palmer 951* (M); common in low ground, Lakeside Park, Jasper Co., 27

Sept., 1908, *E. J. Palmer 1550* (M); Carthage, 25 Aug., 1907, *E. J. Palmer 1075* (M); Bismark, Iron Mt., 17 Aug., 1897, *Trelease 515* (M); Terre Blene Creek, St. Genevieve Co., 14 Oct., 1897, *Trelease 507* (M); Bridgeton, 22 July, 1859, *Fritchey* (M); Swan, 1 Oct., 1899, *Bush 722* (M); wet ground, Galena, Stone Co., 14 Oct., 1913, *E. J. Palmer 4663* (M); Warsaw, Benton Co., 26 Aug., 1897, *Trelease 516* (M); Big River, Jefferson Co., 23 July, 1885, *Wislizenus 266* (M).

Arkansas: Fulton, 18 Sept., 1900, *Bush 921* (M); Little Buffalo, Hanly, Shary Co., Aug., 1913, *Emig 69* (M); Bradley's Ferry, 27 July, 1913, *Emig 19* (M); Springtown, Benton Co., 1 Aug., 1913, *Emig 176* (M); Little Rock, July, 1886, *Hasse* (Stanford).

Kansas: wet soil, Doniphan Co., 31 July, 1897, *Whitford 1081* (M); St. George, 27 Sept., 1892, *Carleton* (M); Ward, 1890, *Darnell 49* (Ore.).

Oklahoma: on wet creek bank near Pawhuska, Osage Co., 9 Aug., 1913, *Stevens 2003½* (M and Stanford); Tishomingo, Johnston Co., 10 Sept., 1914, *E. J. Palmer 6488* (M).

Indian Territory: Sapulpa, 22 July, 1894, *Bush 405* (M).

Texas: sandy swamps, San Augustine, 8 Sept., 1916, *E. J. Palmer 10648* (M).

Mississippi: Oktibbeka Co., 11–17 Aug., 1896, *Pollard 1323* (M and Cornell); wet places, Panola Co., 17 Sept., 1896, *Eggert* (M); Taylorville, 21 Aug., 1903, *Tracy 8711* (M).

Louisiana: Monroe, 15 Oct., 1915, *E. J. Palmer 8942* (M).

Alabama: Tensaw, 18 Aug., 1904, *Tracy 8011* (Cornell and M).

This species and *M. ringens* are the common blue-flowered *Mimuli* of the eastern states. The floral structure of both of them is remarkably constant when compared with the western species. *M. alatus* differs from *M. ringens* mostly in the length of the pedicels and in having petioled leaves.

3. **M. gracilis** R. Br. Prodr. 439. 1810, and 123. 1821; Benth. Scroph. Ind. 29. 1835; DC. Prodr. **10**: 369, 594. 1846; Benth. & Mueller, Fl. Austr. **4**: 482. 1869; Mueller, Frag. **6**: 103. 1867–68; Hook. Fl. Brit. Ind. **4**: 259. 1884; Moore, Fl. New South Wales, 337. 1893.

M. strictus Benth. in Wall. Cat. no. 3918. 1828; Scroph. Ind. 28. 1835; G. Don, Hist. Dichlam. Pl. **3**: 553. 1838.

M. striatus Walp. Rep. 3: 275. 1844–45, *sphalm* (for *strictus*).
M. pusillus Benth. in DC. Prodr. 10: 369. 1846.
M. angustifolius Hochst. ex A. Rich, Tent. Fl. Abyss. 2: 119. 1851; Walp. Ann. 3: 192. 1852–53; Kuntze, Rev. Gen. Pl. 3: 236. 1893.

A slender glabrous perennial, rhizome creeping; stem erect, 1.5–3 dm. high, simple or branched from near the base, quadrangular, the angles winged; leaves linear-oblong or lanceolate, obtuse, .8–5 cm. long, 1–10 mm. broad, 1-nerved, sessile, clasping at the broad base or subauriculate, entire or occasionally denticulate; flowers in a loose raceme, pedicels elongated, 3 or more times the length of the corolla; calyx tubular, much distended by the mature capsule, 6–7 mm. long, ribs more or less purplish, teeth equal or nearly so, short, deltoid-lanceolate, sinuses broad, scarious, sometimes cleft; corolla 1.2–1.5 cm. long, blue or violet-purple, occasionally white or pink, tube and throat broad, exserted, lobes broad, nearly truncate, minutely ciliate, upper lip erect and much shorter than the spreading lower lip, throat nearly closed by the prominent hairy palate; stamens glabrous, included, filaments thickened along the lower part; style glabrous, included, with a persistent tubercular enlargement at the base, stigma-lobes equal, broadly rounded, laciniate; capsule included, oblong; seeds oblong, reticulate.

Distribution: in wet places in Australia, India, and South Africa.

Specimens examined:

India: Chota Nagpur, Feb., 1903, *Prain 71* (Pomona); Lodh, Kumaon, 5000 ft. alt., without date, *Strachey & Winterbottom* (G); Changhes, Kashmir, 1 July, 1876, *Clarke 496* (U. S.); Punjab, 1000 ft. alt., without date, *Thomson* (G); in rice fields, Manneri, Himalaya Mts., 5000 ft. alt., 4 June, 1920, *Dudgeon & Kenoyer 141* (M).

Abyssinia: Bahara, Province Sana, 5 Aug., 1841, *Hochstetter 1629* (M).

South Africa: Maputa, 1 Oct., 1909, *Howard 22* (U. S.); south coast of Africa, 9 Oct., without year, *Ecklon* (M); by the Kachu (Yellowwood) River, without date, *Dregè* (M); N. Tondweni, Zululand, 12 May, 1903, *Wood 9193* (U. S.); near

Weenen, Natal, 4500 ft. alt., Dec., 1890, *Wood 1506* (G); Ladysmith, Natal, 18 March, 1894, *Kuntze* (U. S.).

Australia:

New South Wales: Gerilderie, Oct., 1920 *Dwyer* (Wellesley); Mudgee, without date, *Woolls* (G).

Victoria: Lower Loddon, without date, *Mueller* (G); Lower Loddon, without date, *Walter* (M); Swan Hill District, Oct., 1888, *French* (G).

4. **M. madagascariensis** Benth. in DC. Prodr. **10**: 369. 1846.

A tall glabrous perennial; stems erect; leaves few, broadly ovate, obtuse, 1.5–2 cm. long, 8–12 mm. wide, sessile, irregularly dentate, 3-nerved from the broad, clasping base; pedicels stout, longer than the leaves; calyx narrowly cylindrical, 6–7 mm. long, distended by the mature capsule, teeth equal, short, lanceolate-acute; corolla blue, 12–14 mm. long, tube exserted, throat densely bearded on the lower side, partly closed by the prominent palate, upper lip shorter than the lower, margins densely ciliate; stamens and style included; capsule broadly oblong, obtuse; seeds oblong.

Distribution: found only on the Island of Madagascar.

Specimens examined:

Madagascar: Madagascar, without date, *Shufeldt 116* (U. S.); Madagascar, without date, *Lyall* (M, photograph of the type).

This species has the general aspect of *M. gracilis*, differing mainly in having broad, 3-nerved, dentate leaves.

5. **M. linearis** (R. Br.) Wettst. in Engl. & Prantl, Nat. Pflanzenfam. 4^{3b}: 72. 1891.

Uvedalia linearis R. Br. Prodr. 440. 1810, and 124. 1821; G. Don, Hist. Dichlam. Pl. **4**: 555. 1838.

M. Uvedaliae Benth. in DC. Prodr. **10**: 369. 1846; Mueller, Frag. **6**: 103. 1867–68; Benth. & Mueller, Fl. Austr. **4**: 482. 1869; Banks & Solander, Botany Cook's Exp. **2**: 66, *pl. 217*. 1901; Bailey, Fl. Queensland **4**: 1102. 1901.

A small glabrous plant, apparently annual; stem weak, slender, simple or branched, leaves few, linear-lanceolate, 4–12 mm. long, acute, 1-nerved, entire, sessile, internodes elongated; pedicels slender, axillary, 3 or more times the length of the corolla, flower-

ing from near the base; calyx narrowly tubular, arcuate, 4–5 mm. long, teeth very small, triangular-acute, nearly equal, ciliate; corolla 8–10 mm. long, blue or violet, tube white, slightly exserted, throat blue with 2 yellow oblong patches, these white-margined and dotted with red below the lower lip, palate prominent, upper lip longer than the lower one; style and stamens much exserted, stigma-lobes equal; capsule included, oblong, acute, the valves splitting readily.

Distribution: wet places in northern Australia and in Queensland.

Specimens examined:

Australia: North Australia at Pt. Darwin, without date, *Forsythe* (Calif. Acad.).

5a. Var. **lutea** Benth. in Benth. & Mueller, Fl. Austr. **4**: 482. 1869.

M. debilis Mueller in Trans. Phil. Inst. Vict. **3**: 62. 1859; Frag. **6**: 103. 1867–68.

Corolla yellow within, paler outside, throat spotted with red; filaments ciliate.

Distribution: northern Australia.

SECTION 2. ERYTHRANTHE Greene

§2. ERYTHRANTHE Greene in Bull. Calif. Acad. Sci. **1**: 108. 1885.

Eumimulus Gray, Syn. Fl. N. Am. 2^1: 276. 1878, ed. 2, and Suppl. 446. 1886, as to *M. cardinalis*.

Perennial from running rootstocks or from stolons, glandular, viscid-pubescent or viscid-villous; stems mostly terete, stout, and erect; leaves sessile, 3–5-nerved from the base; flowers few, usually terminal; calyx prismatic, strongly angled, not inflated at maturity, teeth equal or unequal; corolla red, bilabiate; stamens exserted, anthers bearded, filaments inflated at the point of insertion; stigma-lips equal, bilamellate; capsule membranaceous, about half as long as the calyx, dehiscent to the base along both sutures, placentae slightly separated at the apex. Sp. 6–9.

Key to the Species

A. Calyx-teeth equal; style exserted.
  a. Corolla-tube little longer than the calyx..................*6. M. cardinalis*
  b. Corolla-tube much longer than the calyx.
    α. Pedicels shorter than the leaves; stems mostly prostrate..*7. M. rupestris*
    β. Pedicels longer than the leaves; stems erect..........*8. M. verbenaceus*
B. Calyx-teeth unequal; style included........................*9. M. Nelsonii*

6. **M. cardinalis** Dougl. in Benth. Scroph. Ind. 28. 1835; Benth. in DC. Prodr. **10**: 370. 1846; D. Don in Brit. Flower Gard. **4**: *pl. 358.* 1836; Gray in Proc. Am. Acad. **11**: 98. 1876; Bot. Calif. **1**: 566. 1876; Syn. Fl. N. Am. **2**^{1}: 276. 1878, and ed. 2, 1886; Greene in Bull. Calif. Acad. Sci. **1**: 108. 1885; Manual Bay Region, 276. 1894; Conzatti & Smith, Fl. Sin. Mex. 117. 1897; Jepson, Fl. W. Mid. Calif. 405. 1901, and ed. 2, 378. 1911; Howell, Fl. Northwest Am. 519. 1901; Eastwood, Fl. South Fork King's River, Sierra Club Publ. 27: 64. 1902; Abrams, Fl. Los Angeles, 365. 1904, and ed. 2, 336. 1917; Hall, Yosemite Fl. 222. 1912.

Erythranthe cardinalis Spach, Hist. Nat. Veg. Phaner. **9**: 313. 1840.

Diplacus cardinalis Grönland in Rev. Hort. IV. **6**: 137. 1857.

M. cardinalis var. *rigens* Greene, Leafl. Bot. Obs. & Crit. **2**: 2. 1909.

M. cardinalis var. *griseus* Greene, Leafl. Bot. Obs. & Crit. **2**: 2. 1909.

M. cardinalis var. *exsul* Greene, Leafl. Bot. Obs. & Crit. **2**: 2. 1909.

A freely branching perennial, villous throughout and more or less viscid; stems 2.5–3 dm. long, from a running rootstock, hollow, erect and more or less rigid to weak and somewhat procumbent, or occasionally climbing over low shrubs; leaves obovate or oblong, 2–11 cm. long, 1–4 cm. wide, sessile by a broad base, auriculate, yellowish-green, frequently almost hoary, 3–5-nerved from the base, thin, margins regularly or irregularly serrate, teeth salient and often with a smaller tooth between the indentations; pedicels stout, longer than the leaves; calyx tubular or oblong-prismatic, 1.8–2.5 cm. long, often finely dotted with red, the ribs more or less tinged with red, teeth 4–5 mm. long,

equal, broadly ovate, acute or acuminate, ciliate; corolla strongly bilabiate, 4–5 cm. long, varying in color from brilliant scarlet to pale reddish-yellow, rarely yellow, broadly cylindrical, tube mostly slightly exserted, orange, striped with red, lobes emarginate, the upper lip erect with the lobes turned back, the middle lobe of the lower lip spreading, the lateral ones strongly reflexed, ciliate at the sinuses; stamens much exserted and partly enclosed by the upper lip, filaments glabrous, anthers yellow, densely villous with soft, white, flat hairs; style longer than the stamens, stigma lips oblong, ciliate; capsule included, oblong, acuminate; seeds oblong, reticulate.

Distribution: common in shaded places along streams from Utah and Arizona, west to Oregon and Lower California.

Specimens examined:

Arizona: Chaperon Canyon, Chiricahua Mts., 7300 ft. alt., 1 July, 1907, *Blumer 1551* (M and Stanford); near Soldier's Camp, Santa Catalina Mts., 13 July, 1916, *Harris C16295* (U. S.); Mt. Graham, 9250 ft. alt., Aug., 1874, *Rothrock 401* (G); southeastern Arizona, 1894, *Price* (Stanford); Mt. Lemmon, Santa Catalina Mts., 2 Aug., 1916, *Harris C16440* (M); Santa Catalina Mts., Pima Co., 8000–10000 ft. alt., June, 1891, *Rhoads* (Phil.); Fort Grant, Pinaleno Mts., Graham Co., 16 July, 1917, *Munz 1207* (Cornell and Pomona).

Nevada: Eagle Valley, Ormsby Co., 19 July, 1902, *C. F. Baker 1336* (M, R. Mt., and Pomona).

Oregon: Rogue River, Jackson Co., 7 July, 1892, *Hammond 310* (M); Deer Creek Valley, Josephine Co., 4–16 July, 1919, *Dale* (Stanford); Brookings, Curry Co., May, 1915, *Thompson 209* (Stanford); Snow Camp, Curry Co., 4000–4250 ft. alt., July, 1916, *J. H. Thompson 26* (Stanford); Grant's Pass, 24 May, 1884, *Howell 382* (Phil. and Ore.); Grant's Pass, 31 Aug., 1889, *Munson & Hopkins* (U. S.).

California: Big River, Mendocino Co., July, 1903, *McMurphy 295* (Stanford); Mendocino, Aug., 1898, *H. E. Brown 865* (M, Phil., Cornell, and R. Mt.); Fort Bragg, 1914, *Mathews 177* (Calif.); Shasta Co., 1896, *Stone* (M); Dutch Flat, Placer Co., July, 1900, *Cole* (R. Mt.); marshy soil in oak grove, Phillips Ranch, Colusa Co., 9 July, 1916, *Stinchfield 417* (Stanford);

Colby, Butte Co., Aug., 1896, *Bruce 859* (M); De Sabla, Butte Co., 6 June, 1917, *Edwards* (Stanford); Agricultural Station, Amador Co., July, 1891, *Hansen 134* (M and Stanford); wet ditch, Plymouth, Amador Co., 26 June, 1903, *Gross 23* (Stanford); Big Tree Grove, 1873, *Lemmon* (Phil.); San Antonio Creek, below the Falls, Calaveras Co., 24 Aug., 1906, *Dudley* (Stanford); Washington Flat, Calaveras Co., 5 Aug., 1890, *Jepson 26m* (Calif.); Spring Gulch, vicinity of Rawhide, Tuolumne Co., 31 July, 1915, *Stinchfield 14* (Stanford); near Yosemite, 9 Aug., 1891, *Coville & Funston 1855* (Cornell); Mariposa, 27 Sept., 1903, *Congdon* (M); Stockton Creek, Mariposa Co., 10 Aug., 1892, *Congdon* (Stanford); trail to Yosemite Point, Yosemite Valley, 2 June, 1894, *Burnham* (Cornell); trail from Huntington Lake to Cascada, Fresno Co., 6 July, 1918, *A. L. Grant 1397* (M); South Fork Kaweah River, Tulare Co., 22 July, 1904, *Culbertson*, distributed as *C. F. Baker 4291* (M and Pomona); Colony Spring, Tulare Co., Aug., 1900, *Dudley 3340* (Stanford); Simpson Meadow, Middle Fork King's River, July, 1913, *Eliot* (Calif.); King's Canyon Road, west of Carson, 31 Aug., 1901, *Steinmetz* (Stanford); near Bartlett Springs, Lake Co., Aug., 1916, *A. S. Stinchfield* (Stanford); Rockville, Solano Co., 1 Aug., 1880, *Earle* (M); mts. near Napa, 13 Aug., 1874, *Parry 353* (M); Weldon Cañon, Solano Co., 13 Sept., 1891, *Jepson* (Calif.); Adobe Cañon, Sonoma Co., June, 1893, *Michener & Bioletti* (Pomona); Sebastapol, Sonoma Co., 12 July, 1907, *Dows* (Stanford); Sausalito, 12 Aug., 1872, *Redfield 6103* (M); San Pablo, July, 1896, *King* (Pomona); banks of creeks, San Francisco, 1865, *Bolander* (M); Redwood Canyon, near Oakland, 11 Sept., 1915, *Abrams 5485* (Stanford); Oakland Hills, 1865, *Bolander 96* (M); Lake San Andreas, San Mateo Co., July, 1903, *Elmer 4941* (M, Stanford, and Pomona); Wright's, Santa Clara Co., July, 1885, *Rattan* (Stanford); Los Gatos Creek, 18 June, 1891, *McCormick & Hammond* (Ore.); Swanton, Santa Cruz Co., 6 June, 1912, *Rich* (Stanford); Carmel Bay, Sept., 1902, *Elmer 4056* (Stanford); Tassajara Hot Springs, June, 1901, *Elmer 3359* (M and Stanford); wet ground, by road below Bisses Station, Kern Co., 27 June, 1895,

Dudley 430 (Stanford); north of San Luis Obispo, June, 1881, *Rattan* (Stanford); Friar's Harbor, Santa Cruz Island, 29 July, 1923, *A. L. Grant 1701* and *1702* (Calif.); Santa Barbara, 1874, *Monks 6* (Phil.); Ojai Valley, Ventura Co., 1 July, 1915, *Thacher 56* (Calif.); Friar's Harbor, Santa Cruz Island, 3 Sept., 1903, *J. Grinnell 8* (Stanford); Avalon, Santa Catalina Island, Aug., 1896, *Trask* (M); Santa Catalina Island, 21–26 April, 1904, *Grant & Wheeler 6143* (M and R. Mt.); cañons, Sierra Santa Monica, April, 1889, *Hasse* (M); Sturtevant's Camp, Mt. Wilson, 25 July, 1901, *G. B. Grant 4454* (Stanford); Rock Creek, desert slopes of the San Gabriel Mts., 3800 ft. alt., 2–4 July, 1908, *Abrams & McGregor 530* (Stanford); Russell's Lake, Los Angeles Co., 18 July, 1913, *Abrams 5017* (Stanford); Pocoima Canyon, 28 July, 1918, *Hitchcock 24* (Pomona); Live Oak Cañon, Claremont, 16 July, 1915, *Crawford* (M and Pomona); San Antonio Cañon, San Antonio Mts., 8000 ft. alt., 28 July, 1917, *I. M. Johnston 1524* (M and Stanford); San Antonio Cañon, near Claremont, 2 Aug., 1903, *C. F. Baker 3457* (M and Pomona); in dense masses about springs, Icehouse Cañon, San Antonio Mts., 6500 ft. alt., 16 June, 1918, *Parish 11980* (M); Little Santa Anita Canyon, Los Angeles Co., 1 July, 1902, *Abrams 2616* (M and Stanford); Sandy Creek bank, Verdugo Cañon, Los Angeles Co., 25 June, 1915, *Macbride & Payson 750* (R. Mt.); Buckhorn Cañon, San Gabriel Mts., 30 Aug., 1917, *F. Grinnell, Jr.* (Stanford); Fall Creek, San Bernardino Mts., 7 Sept., 1915, *Gardner 531* (M and Pomona); stream banks, San Bernardino Co., July, 1890, *Parish* (M); vicinity of San Bernardino, 1000–1500 ft. alt., 10 July, 1896, *Parish 4189* (M); river banks, Victorville, 25 June, 1915, *Parish 10544* (Stanford); borders of streams, San Bernardino Mts., 1882, *Parish & Parish 119* (Stanford); Strawberry Valley, San Jacinto Mts., 5200 ft. alt., July, 1901, *Hall 2382* (M and Stanford); Jamul Valley, San Diego Co., 2 July, 1894, *Schoenfeldt 3835* (Stanford); Jamul Valley, 1500 ft. alt., June, 1895, *Stokes* (Stanford); Alpine, San Diego Co., 6 Aug., 1894, *Mearns 3948* (Stanford); Alpine, San Diego Co., 14 Aug., 1894, *Mearns 4030* (Stanford); mountains of San Diego Co., 25 July, 1882, *H. C. Orcutt 132* (M); San Diego,

1874, *Cleveland* (M); Fort Tejon, 1857–58, *de Vesey 65* (Phil.); California, *Douglas* (G).

Mexico:

Lower California: San Pedro Martir, Aug., 1903, *Robertson 26* (Calif.); Tecate River, near Monument 245, 23 June, 1894, *Schoenfeldt 3762* (Stanford); Socorro, 27 April, 1886, *Orcutt* (M); Cedros Island, July–Oct., 1896, *Anthony 39* (Phil., M, and Stanford); Santa Tomas, northern Lower California, 17 July, 1885, *Orcutt* (Calif).

The corollas of the specimens of *A. L. Grant 1702* are deep canary-yellow with three red stripes down the throat below the lower lip. The specimens of Orcutt from Santa Tomas are also labeled "yellow flowers."

7. **M. rupestris** Greene, Leafl. Bot. Obs. & Crit. 2: 3. 1909.

Stems mostly prostrate and frequently rooting at the nodes, the whole plant viscid-villous; leaves numerous, oblong or elliptical, 2–5 cm. long, .8–2.2 cm. wide, broadly sessile, 3-nerved from the base, saliently and coarsely toothed along the upper half; pedicels slender, somewhat quadrangular, shorter than the leaves; calyx cylindrical, 1.8–2 cm. long, teeth equal, triangular-acute, 4–5 mm. long, ciliate; corolla 4–5 cm. long, scarlet, more or less tinged with yellow, the tube slender, funnelform, more than twice as long as the calyx, throat ampliate, upper lip erect and longer than the spreading lower one; anthers hispid, horseshoe-shaped; style about as long as the corolla, stigma-lips long-oblong; capsule oblong; seeds oblong, apiculate at each end, favose-pitted.

Distribution: known only from the type locality.

Specimens examined:

Mexico:

Morelos: wet cliffs, Sierra de Tepoxtlan, 7500 ft. alt., 6 May, 1900, *Pringle 8348* (U. S., TYPE, Phil., and Pomona).

8. **M. verbenaceus** Greene, Leafl. Bot. Obs. & Crit. 2: 2. 1909.

M. lugens Greene, Leafl. Bot. Obs. & Crit. 2: 3. 1909.

Upright stems from a creeping rootstock, simple or branched, more or less quadrangular, villous or pubescent with some gland-

ular hairs; leaves elliptical, obovate, rhombic-ovate or occasionally spatulate, 5–7.5 cm. long, 1.5–3 cm. wide, saliently and coarsely toothed above the middle, the serrations sometimes continuing to the broad, frequently subcordate sessile base, 3–5-nerved from the base, the upper surface occasionally marked with a broad, irregular, somewhat triangular reddish-brown band; pedicels slender, quadrangular, 7–10 cm. long, generally exceeding the subtending leaves; calyx prismatic, 2–2.8 cm. long, more or less white-villous at the base and often tinged or shaded with red, teeth equal, broadly deltoid-subulate, 5–6 mm. long; corolla 3.5–5.5 cm. long, rarely obscurely bilabiate, crimson, often tinged with yellow, the tube much exserted, broadly funnelform, throat ampliate, lobes nearly equal, frequently emarginate and more or less truncate, the upper lip erect, the lower lip somewhat spreading; stamens much exserted, style about as long as the corolla, stigma-lips oblong, rounded; capsule oblong; seeds oblong, longitudinally wrinkled.

Distribution: north-central and southern Arizona to northern Mexico.

Specimens examined:

Arizona: Shinamo Creek, Grand Canyon, 21–26 Oct., 1906, *Pilsby* (Phil.); Bright Angel Trail, Grand Canyon, without date, *Shockley* (Stanford); Clear Creek, central Arizona, 14 Aug., 1891, *McDougal* (U. S.); crevices in perpendicular walls of the canyon where water drips out, Clear Creek, Camp Verede, 9 Aug., 1891, *Toumey* (U. S., TYPE); Hermit Cave, Grand Canyon, 8 May, 1922, *Wiegand & Upton* (Cornell); along swift streams, Ramsey Cañon, Huachuca Mts., 10 June, 1909, *Goodding 135* (G and R. Mt.); edge of creeks and under overhanging rocks, Ramsey Cañon, Huachuca Mts., 20 Aug., 1910, *Goodding 739* (G and R. Mt.); Huachuca Mts., 29 June–5 July, 1903, *Griffiths 4815* (U.S. and M); Huachuca Mts., 5 June, 1897, *Breninger* (G); Fort Huachuca, 1890, *Patzky* (U. S.); shady river banks, Rio Verde, 10 Oct., 1865, *Coues & Palmer 596* (M); Fort Huachuca, 26 April–21 May, 1890, *Edw. Palmer 441* (G); near Fort Huachuca, 1894, *Wilcox 119* (U. S.).

Mexico:

Chihuahua: Guayanopa Canyon, Sierra Madre Mts., 3600 ft. alt., 24 Sept., 1903, *Jones* (Pomona).

Sinaloa: Sierra de los Alamos, 25 March–8 April, 1890, *Edw. Palmer 328* (U. S.); high up in the Sierra de Alamos, 19 March, 1910, *Rose, Standley & Russell 13074* (U. S.); sandy soil along the river, near Fuerte, Sinaloa, 27 March, 1910, *Rose, Standley & Russell 13381* (U. S.).

9. **M. Nelsonii** Grant[1]

Stems more or less quadrangular, viscid-villous, erect and branched or somewhat procumbent; leaves elliptical or ovate-lanceolate, 3–8 cm. long, .7–2 cm. wide, saliently toothed, sessile by a broad subcordate base, sparingly pubescent, 3-veined from the base; pedicels quadrangular, longer than the leaves; calyx broadly cylindrical, 3.4–3.7 cm. long, pubescent, teeth unequal, triangular-acute, about one-third as long as the tube, the throat oblique; corolla 5–6.5 cm. long, crimson, more or less shaded with yellow, the tube cylindrical, much exserted, throat ampliate, sparingly pubescent within, lobes of the upper lip longer, erect, almost truncate, those of the lower lip shorter and spreading, slightly emarginate; stamens exserted, attached near the base of the tube, filaments thin, broad, anthers horseshoe-shaped, villous; style included, shorter than the calyx, glabrous, stigma-lips truncate, slightly erose; capsule unknown.

Distribution: known only from the type locality.

Specimens examined:

Mexico:

Durango: Sierra Madre, 30 miles north of Guanaceri, 8000–9000 ft. alt., 18 Aug., 1898, *Nelson 4775* (U. S. Nat. Herb., TYPE).

M. Nelsonii is unique in this section on account of its unequal calyx-teeth and its short style.

[1] **Mimulus Nelsonii** Grant, sp. nov., caulis ramique viscoso-villosi; foliis ellipticis ovatis lanceolatisve, dentatis, sessilibus, 3–8 cm. longis; calyce late cylindrato, 3.4–3.7 cm. longo, pubescente, dentibus inaequalibus, ore obliquo; corolla 5–6.5 cm. longa, coccinea, tubo multo exserto, lobis inaequalibus; staminibus exsertis, antheris villosis; stylo calyce breviore.—Collected at Sierra Madre, 30 miles north of Guanaceri, Durango, 8000–9000 ft. alt., 18 Aug., 1898, *E. W. Nelson 4775* (U. S. Nat. Herb., no. 332825, TYPE).

Section 3. Simiolus Greene

§3. Simiolus Greene in Bull. Calif. Acad. Sci. 1: 109. 1885, in part.

Annuals or perennials, glabrous or pubescent; leaves variable; calyx becoming inflated at maturity and loosely investing the membranaceous capsule, teeth unequal, the lower usually curved upwards over the lateral teeth, partly or nearly closing the orifice; corolla distinctly bilabiate with two prominent hairy ridges below the lower lip, these sometimes almost closing the throat; stamens included, glabrous; style glabrous or puberulent, included; capsule dehiscent to the base along both sutures, placentae completely united. Sp. 10–25.

Key to the Species

A. Corolla-throat open; flowers axillary, in a loose few-flowered raceme or solitary; stems low, mostly creeping or procumbent.
  a. Calyx-teeth 5.
    α. Corolla more than 2.5 cm. long.
      I. Leaves in a basal rosette..........................*12. M. acaulis*
      II. Leaves mostly cauline.
        1. Leaves broadly ovate or rounded, 5–7-nerved; corolla yellow, sometimes with red or pinkish-purple spots..........*10. M. luteus*
        2. Leaves subrhombic-ovate or elliptical, mostly 3–5-nerved; corolla copper-colored when mature............*11. M. cupreus*
    β. Corolla less than 2.5 cm. long.
      I. Leaves mostly suborbicular, more or less covered with short stiff, white hairs; corolla laciniately lobed or erose..*21. M. dentilobus*
      II. Leaves broadly ovate to suborbicular, glabrous or nearly so; corolla-lobes mostly entire.
        1. Stems glabrous or nearly so.
          * Leaves radical; flowers subsessile..............*23. M. depressus*
          ** Leaves mostly cauline; pedicels longer or shorter than the leaves..................................*25. M. glabratus*
        2. Stems not glabrous.
          * Stems erect, glandular-villous..................*19. M. Whipplei*
          ** Stems prostrate, densely pubescent.
            † Leaves sessile or short-petioled.
              ‡ Whole plant pubescent................*24. M. pilosiusculus*
              ‡‡ Upper part of stems pubescent...*25a. M. glabratus* var. *parviflorus*
            †† Leaves long-petioled........................*22. M. crinitus*
  b. Calyx-teeth 3...*20. M. pallens*
B. Corolla-throat partly or nearly closed by the prominent palate; flowers commonly numerous in a definite raceme, sometimes few-flowered.
  a. Upper calyx-tooth rarely more than twice the length of the others, the lower teeth in maturity usually folding over and partly closing the orifice.

α. Upper leaves glaucous or pubescent, conspicuously connate-perfoliate..*15. M. glaucescens*
β. Upper leaves not glaucous nor pubescent, seldom connate.
I. Leaves dentate or denticulate, occasionally lyrate.
1. Leaves broadly ovate, oblong, elliptical, or rounded.
* Flowers mostly in definite racemes; pedicels usually shorter than the corollas; rootstocks rarely fleshy or yellow..*14. M. guttatus*
** Stems mostly 1–3, rarely 5-flowered, coming from a mass of fleshy, yellowish rootstocks; pedicels usually longer than the corollas..............................*13. M. Tilingi*
2. Leaves narrowly spatulate or oblanceolate, the upper mostly linear..*16. M. nudatus*
II. Leaves pinnately lobed, cut, or parted..............*18. M. laciniatus*
b. Upper calyx-tooth almost three times the length of the others, the lower teeth in maturity folding over and nearly closing the orifice ....*17. M. nasutus*

10. M. luteus L. Sp. Pl. ed. 2, 884. 1763; Willd. Sp. Pl. **3**: 361. 1800; Lindl. in Bot. Reg. **12**: under *pl. 1030.* 1826; Hook. in Curtis, Bot. Mag. II. **8**: under *pl. 3336.* 1834; Benth. Scroph. Ind. 28. 1835; DC. Prodr. **10**: 370. 1846, in part; Hook. & Arn. Bot. Beechey's Voyage, 40. 1841; Clos in C. Gay, Hist. Chile **5**: 140. 1849; Planchon in Fl. des Serres **9**: 1. 1853–54; Reiche, Fl. Chile **6**^{1}: 60. 1911.

M. luteus subvar. *macrophyllus* Clos in C. Gay, Hist. Chile **5**: 140. 1849; Reiche, Fl. Chile **6**^{1}: 60. 1911.

M. aurantiacus Renjifo, Anal. Univ. Santiago **65**: 301. 1884, not Curtis.

M. luteus var. *aurantiacus* (Renjifo) Reiche, Fl. Chile **6**^{1}: 60. 1911.

A creeping glabrous perennial, freely rooting from the nodes; stem terete, 1–3 dm. long, decumbent or prostrate; leaves numerous, broadly ovate, acute, 2.5–3 cm. long, nearly as broad, regularly serrate, 5–7-nerved from the base, the lower short-petioled, upper sessile, clasping; flowers few, pedicels 3 or more times as long as the calyx, much longer than the subtending leaves; calyx campanulate, 1.5–2 cm. long, teeth triangular-acute, the upper longer; corolla 3–4 cm. long, tube slender, exserted, lobes spreading, middle lobe of the lower lip longer than the others, throat red-maculate; stamens and style glabrous.

Distribution: common along streams and in moist places in Chile.

Specimens examined:

Chile: Chile, without date, *Styles* (Phil.).

The plants of this species are commonly called "placa" in Chile and the more succulent, tender-leaved ones are eaten either as a salad or cooked in soup.

M. luteus was first collected by Father Feuillee along a river bank in Conception, Chile, about 1714. He described and pictured it as "*Gratiola foliis subrotundus, nervosis, floribus luteus,*" and, so far as known, no specimens were made nor seeds sent to Europe. Linnaeus referred to Feuillee's description and plate when he transferred the yellow-flowered plant to the genus *Mimulus* and nothing more was known of it for some time. Langsdorff, early in the next century, sent some seed from Unalaska; plants from these were named *M. guttatus* by Fischer in 1812. De Candolle took up this name in 1813, fully describing the species and noting some of its differences from *M. luteus.* Other botanists, however, did not agree with this view and believed that the plants from North America and those pictured by Feuillee were conspecific. Several years later, seeds were sent from South America by various collectors so that it was possible to distinguish the *M. luteus* of Feuillee from the yellow-flowered North American *Mimulus* that had been confused with it. *M. luteus* resembles *M. guttatus* rather closely, but can be separated from it, in general, by its creeping habit, its fewer flowers with pedicels 3 or more times longer than the calyx, its mostly glabrous condition, and its more open corolla with a relatively narrow tube. The throat in *M. guttatus* is nearly closed by the two hairy ridges running down the lower side, whereas the throat in *M. luteus* is wide open.

This species, like its North American relative, is polymorphic and several varieties and species have been described, dependent on the color and the number and size of the spots, if present, on the lobes of the corolla. More material for study as to differences or intergradations might modify one's concept of the group as a whole, but, after examining the specimens available, it seems best to keep the following as varieties.

10a. Var. **rivularis** Lindl. in Bot. Reg. **12:** *pl. 1030.* 1826; Lodd. in Bot. Cab. **16:** *pl. 1575.* 1829; Hook. in Curtis, Bot. Mag. II. **8:** under *pl. 3336.* 1834.

M. guttatus Reichenb. Icon. Pl. Cult. **3:** *pl. 204.* 1827–30, not DC.

Stems decumbent or ascending; leaves coarsely toothed, more or less tinged and spotted with red; calyx tinged with red; corolla yellow, lobes unequal, almost truncate, a large reddish spot on the middle lobe of the lower lip and numerous small spots down the throat.

Distribution: along streams and in wet places in Chile.

Specimens examined:

Chile: Maipo River, Santiago, about 6000 ft. alt., Jan., 1892, *Kuntze* (U. S.); in a swamp near Schniedeberg, Silesia, without date, *Buck* (M).

10b. Var. **variegatus** (Lodd.) Hook. in Curtis, Bot. Mag. II. **8:** *pl. 3336.* 1834; Lindl. in Bot. Reg. **21:** *pl. 1796.* 1836; C. Gay, Hist. Chile **5:** 140. 1849; Reiche, Fl. Chile **6**[1]**:** 60. 1911.

M. variegatus Lodd. in Bot. Cab. **19:** *pl. 1872.* 1832; Paxt. Mag. Bot. **1:** *pl. 79.* 1834; Planchon in Fl. des Serres **9:** 2. 1853–54.

M. ocellatus Bert. ex Steud. Nom. ed. 2, 150. 1841.

Stems erect, leaves thin, ovate to oblong, these and the calyx usually tinged with red; corolla pale yellow, the lobes more or less deeply banded with pinkish-purple at the margins, throat spotted with numerous small red dots.

Distribution: known only from Chile and from cultivated specimens.

Specimens examined:

Chile: Quillota, 1829, *Bertero* (M); Chile, without date, *Bertero 1148* (G); in swamps near Aculeo and in Mt. Leona Rancagua, without date, *Bertero 437* (G and M); Chile, without date, *Dr. Styles* (Phil.).

10c. Var. **Youngana** Hook. in Curtis, Bot. Mag. II. **8:** *pl. 3363.* 1834; C. Gay, Hist. Chile **5:** 140. 1849; Reiche, Fl. Chile **6**[1]**:** 60. 1911.

M. Smithii Lindl. in Bot. Reg. **20**: *pl. 1674*. 1835, not Paxton.

Stems ascending or decumbent; calyx oval, more or less spotted with red; corolla deep yellow, throat dotted with red and each lobe with a large broad reddish spot near the margin.

Distribution: known only from Chile and from specimens cultivated in European gardens.

10d. Var. **nummularis** C. Gay, Hist. Chile **5**: 140. 1849; Reiche, Fl. Chile **6**[1]: 60. 1911.

M. nummularis C. Gay, Hist. Chile Atl. **1**: *pl. 57*. 1854.

Stems glabrous, 1–2 dm. long, fistulous, decumbent or ascending, rooting freely from the nodes; leaves ovate or elliptical, 1.5–2.5 cm. long, 1–2 cm. wide, acute, coarsely serrate, sessile and clasping or tapering to a short broad petiole, 3–5-nerved; flowers few in a terminal raceme, rarely solitary, pedicels longer or shorter than the subtending leaves, stout, somewhat quadrangular; calyx campanulate, 1.5–2 cm. long, more or less spotted or tinged with red, teeth broadly triangular-acute, the upper larger; corolla 3.5–4.5 cm. long, yellow, tube slender, throat wide open, lobes unequal, upper lip erect, middle lobes of the spreading lower lip with a single large spherical reddish spot near the center and numerous small dots down the throat; capsule stipitate; seeds longitudinally striate.

Distribution: along streams and in swampy places in Chile.

Specimens examined:

Chile: swampy places and brooks near Rio Colorado, in the vicinity of Santiago, 15 Feb., 1902, *Hastings 523* (Cornell and U. S. no. 530408).

10e. Var. **alpinus** Lindl. in Bot. Reg. **12**: under *pl. 1030*. 1826; Hook. in Curtis, Bot. Mag. II. **8**: under *pl. 3336*. 1834.

A coarse, short-stemmed, puberulent perennial; stems 9–15 cm. high, erect; leaves ovate or ovate-lanceolate, 1.5–3 cm. long, .8–1.5 cm. broad, coarsely and irregularly toothed, 5-nerved, generally short-petioled with a broad base, upper leaves sometimes sessile; flowers few, mostly solitary, terminal, pedicels 2 or more times as long as the subtending leaves, usually quadrangular; calyx frequently spotted with red, teeth broadly ovate, the upper

one much longer; corolla yellow, throat broadly oblong, lobes little spreading, the lower with a large round reddish spot near its center.

Distribution: known only from specimens collected in the mountains of Argentine Republic. The type was collected by Gillies near Mendoza.

Specimens examined:

Argentine Republic: near La Guardia, Catamarca, 1829, *Gillies* (G); Cieneja de la Cesveyas, Jan., 1829, *Gillies* (G); La Allada, 4 June, 1916, *Jörgensen 1268* (G and M).

Further collections might show that this plant is entitled to specific rank.

11. M. cupreus Dombrain in Fl. Mag. **2**: *pl. 70.* 1862; Regel in Gartenfl. **13**: 3, *pl. 422, fig. 1.* 1864 (amplified description); Reiche, Fl. Chile **6**[1]: 61. 1911.

M. luteus var. *cuprea* Hook. in Curtis, Bot. Mag. III. **20**: *pl. 5478.* 1864.

A glabrous or puberulent annual, branching freely from the base, more or less dwarfed and somewhat compact; stems terete, 1–2 dm. high; leaves subrhombic-ovate or elliptical, 1.5–3 cm. long, .8–2 cm. wide, sessile or subsessile, 3–5-nerved from the base, irregularly and coarsely serrate; flowers numerous, pedicels mostly shorter than the subtending leaves or sometimes much longer; calyx campanulate, more or less spotted with red, teeth triangular-acute, the upper one longer, broader, obtuse; corolla 2.5–3.5 cm. long, tube yellow, throat expanded, spotted with red below the lower lip, lobes spreading, golden-yellow, becoming a brilliant copper color at maturity; capsule constricted at the base but not stipitate; seeds longitudinally striate.

Distribution: known only from southern Chile.

Specimens examined:

Chile: Santiago, U. S. Expl. Exp., 1838 (G); Province Colchagua, 1862, *Bridges* (or ? *Cuming*) (U. S. no. 259695); Chile, without locality or date, *Gay* (G).

M. cupreus was one of the popular garden plants of the middle 18th century. Seeds of it were collected by a Mr. Pearce in the mountains near Chillan, in southern Chile, and were sent by him

to Europe. The original description and illustration were made from cultivated plants.

12. **M. acaulis** Phil. in Anal. Univ. Chile 91: 112. 1895.

M. depressus var. *acaulis* (Phil.) Reiche, Fl. Chile 6[1]: 62. 1911.

Plants small; leaves in a basal rosette, rhomboid, 1.5–1.6 cm. long, 9 mm. broad, short-petioled, upper leaves incise-dentate; pedicels short, 1-flowered; calyx 6 mm. long; corolla 2.8–3 cm. long, lobes nearly equal; stamens and style short.

Distribution: in the Andes in Illapel, Province of Coquimbo, Chile. Locally called "La Polcura."

The shape of the leaves and the short-pedicelled flowers indicate that this species is distinct from *M. luteus.*

13. **M. Tilingi** Regel in Gartenfl. 18: 321, *pl. 631.* 1869; Greene in Bull. Calif. Acad. Sci. 1: 110. 1885.

M. Pilingi Regel in Gartenfl. 18: *pl. 631.* 1869, *sphalm* (for *Tilingi*).

M. luteus var. *alpinus* Gray in Proc. Acad. Phila. 71. 1863, in part, not Lindl.; Proc. Am. Acad. 11: 98. 1876; Bot. Calif. 1: 567. 1876, in part; Syn. Fl. N. Am. 2[1]: 277. 1878, in part, ed. 2, and Suppl. 448. 1886, in part; Watson in Bot. King's Exp. 224. 1871.

M. Roezli, acc'd. to Gray, Syn. Fl. N. Am. ed. 2, 2[1]: Suppl. 448. 1886.

M. implexus Greene in Jour. Bot. 33: 8. 1895; Piper & Beattie, Fl. Northwest Coast, 325. 1915.

M. minor A. Nels. in Proc. Biol. Soc. Wash. 17: 178. 1904.

M. implicatus Greene, Leafl. Bot. Obs. & Crit. 1: 189. 1905.

M. Langsdorfii var. *minor* (A. Nels.) Cockerell in Daniel, Fl. Boulder, Colorado, 213. 1911.

M. Langsdorfii var. *alpinus* (Gray) Piper in Mazama 2: 99. 1901; Blankinship in Mont. Agr. Coll. Studies 1: 98. 1905.

Low creeping perennials; stems from a mass of yellowish rootstocks, usually freely branched, 5–20 cm. long, more or less weak, commonly stoloniferous, glabrous or pubescent above; leaves few, cauline, light green, broadly elliptical to broadly ovate, acute or sometimes rounded, the lower generally short-petioled,

the upper sessile, rarely connate, 3–5-nerved from the base, irregularly denticulate; flowers few, mostly terminal, pedicels at least $2\frac{1}{2}$ times as long as the mature calyx, ascending, occasionally recurved, slender, puberulent or pubescent; calyx broadly campanulate, 8–14 mm. long, inflated in fruit, generally tinged and thickly dotted with red, teeth broadly ovate, blunt, unequal, the lower ones usually longer than the lateral, the upper at least twice as long as the others, villous at the sinuses; corolla 2–3.5 cm. long, broadly funnelform, the throat densely bearded and dotted with red, the palate prominent, sometimes nearly closing the throat; style about as long as the throat, sparsely puberulent; capsule oblong or oval, constricted at the base or short-stipitate, blunt, about half the length of the calyx; seeds oblong, reticulate.

Distribution: growing in more or less dense clusters along the edges of creeks or in the midst of shallow rivulets in the high mountains from Montana to Colorado, west to British Columbia and southern California.

Specimens examined:

Montana: Granite Park, Glacier National Park, 10 Aug., 1910, *Kirkwood 51* (M, R. Mt., and Pomona).

Colorado: Breckenridge, 1887, *Bereman 761* (M); moist banks at 10700 ft. alt., Mammoth Gulch, James Peak, 12 Aug., 1919, *Munz 3028* (Pomona); Berthoud's Pass, 23 July, 1881, *Engelmann* (M); Arapahoe Pass, 1904, *Andrews 8* (R. Mt.); Boulder, 10 June, 1901, *Wheeler 312* (R. Mt.); Camp Albion, about 11500 ft. alt., 30 Aug., 1901, *Wheeler 372* (R. Mt.).

Idaho: ridges south from Wiessner's Peak, Coeur D'Alene Mts., about 6000 ft. alt., 28 July, 1895, *Leiberg 1394* (M, R. Mt., and Stanford); near Stevens Peak, 3 Aug., 1895, *Leiberg 1446* (M).

Utah: Alta, Aug., 1879, *Jones* (R. Mt.).

Nevada: Mt. Rose, 9650 ft. alt., 24 Aug., 1912, *Heller 9969* (M).

British Columbia: Ryer's Pass, 29 July, 1890, *Macoun* (M).

Oregon: wet granitic soil, Wallowa Mts., Aug., 1907, *Cusick 3115* (M, R. Mt., and Stanford); Wallowa Mts., 7–8000 ft. alt., 9 Aug., 1900, *Cusick 2468* (Cornell, M, R. Mt., and Calif.); Crater Lake, 26 Aug., 1922, *Epling 5555* (Epling).

California: Mt. Stanford, 19 Aug., 1883, *Sonne 266* (Stanford);

ridge above Donner Pass, Nevada Co., 7500 ft. alt., 10 Aug., 1903, *Heller 7137* (M, R. Mt., and Pomona); Summit Station, Aug., 1883, *Greene* (G); Donner Lake, Aug., 1883, *Greene* (G and M); mountains above Coldstream, Placer Co., 8500 ft. alt., 12 July, 1885, *Sonne 266a* (M); ridge northwest of Donner Pass, 13 Aug., 1917, *Heller 12918* (Cornell, M, and Stanford); Summit Meadows west of Donner Pass, 6800 ft. alt., 26 July, 1919, *Heller 13318* (M); Twin Lakes, Alpine Co., 8500 ft. alt., July, 1892, *Hansen 1289* (M and Stanford); summit of Sonora Pass, Tuolumne Co., 10000 ft. alt., 15 Aug., 1915, *A. L. Grant 320* (M); Mt. Lyell, 9000 ft. alt., 16 July, 1909, *Jepson 3355* (Calif.); in shallow streams, base of Mt. Leavitt, Tuolumne Co., 10500 ft. alt., 29 Aug., 1915, *A. L. Grant 423* (G, Cornell, M, R. Mt., and Calif.); Minarets, Madera Co., 9500 ft. alt., 23 Aug., 1918, *A. L. Grant 1579* (Cornell, M., Calif. Acad., Calif., Stanford, and Pomona); Graveyard Meadow near Silver Pass, Fresno Co., 8500 ft. alt., 18 Aug., 1918, *A. L. Grant 1513* (G, Phil., Cornell, M, and Calif.); Mt. Whitney, 15 Aug., 1904, *Culbertson*, distributed as *C. F. Baker 4544* (M and Pomona); Farewell Gap, Tulare Co., 10400 ft. alt., 23–31 July, 1900, *Jepson 1020* (Calif.); brooks near Farewell Gap, 10300 ft. alt., Apr.–Sept., 1897, *Purpus 5243* (M); slopes of Saw Tooth Peak, Tulare Co., 11000–12000 ft. alt., 10 Aug., 1896, *Dudley 1607* (Stanford); Carson Pass, 8200 ft. alt., 23 Aug., 1918, *Jepson 8091* (Calif.); Onion Valley, near Kearsarge Pass, 15–22 July, 1900, *Jepson 904* (Calif.); Mill Creek Falls, 20 June, 1901, *Parish 5063* (U. S.); wet grassy ground, 9500 ft. alt., 2 July, without year, *Crawford* (Pomona).

There has been considerable confusion regarding the exact status of *M. Tilingi*. Regel grew it from seed sent by Dr. Tiling from near Nevada City, California. He first described and pictured it in Gartenflora **18**: 321, *pl. 631*. 1869. In the next volume (**19**: 290, *pl. 665*. 1870), he described and illustrated another plant which he said came from the roots of the first plant during its second year. The two plants are wholly unlike in habit, in the shape of the leaves and in the shape of the calyx. The second plant closely resembles *M. guttatus*, seed of which had been sent to Regel by Dr. Tiling from Alaska, and it would seem

that in some way the two had become mixed or that seed of *M. guttatus* had fallen on the soil of the pots in which *M. Tilingi* was growing. This species varies considerably in the size of the flowers and leaves. Generally, it may be distinguished by its low, rather closely branching stems, its elliptical or ovate, acute leaves and by its long-pedicelled, chiefly terminal flowers. The rootstocks usually are yellowish and moniliform, but the same thing is found in apparently typical specimens of *M. guttatus* so that this cannot be used as a distinguishing feature as suggested by Greene.

13a. Var. caespitosus (Greene) Grant, comb. nov.

M. Scouleri var. *caespitosus* Greene, Pittonia **2**: 22. 1889.

M. caespitosus Greene in Jour. Bot. **33**: 8. 1895.

M. luteus var. *alpinus* Gray in Proc. Acad. Phila. 71. 1863, not Lindl.; Proc. Am. Acad. **11**: 98. 1876; Bot. Calif. **1**: 567. 1876, in part; Syn. Fl. N. Am. **2**[1]: 277. 1878, in part, ed. 2, and Suppl. 448. 1886, in part.

M. alpinus (Gray) Piper in Contr. U. S. Nat. Herb. **11**: 510. 1906; Piper & Beattie, Fl. Northwest Coast, 325. 1915.

Stems 3–10 cm. long, reddish, stolons abundant, forming a more or less dense tuft, rootstocks few; leaves ovate or elliptical, 2–10 mm. long, dark grass-green, more or less tinged with red, glabrous or puberulent, entire or irregularly denticulate; flowers terminal and mostly solitary.

Distribution: high mountains from British Columbia to Idaho and Washington, southward to central California.

Specimens examined:

British Columbia: Asulkan Valley, Glacier, 4100–6000 ft. alt., 19 July, 1906, *S. Brown 605* (M); Upper Spillimacheen, 6400 ft. alt., 27 July, 1904, *Heacock 407* (M and R. Mt.); by a rivulet, alpine meadow in the Big Bend district, 6000 ft. alt., 4 Aug., 1905, *Shaw 1094* (M); Mt. Cheam, 15 Aug., 1901, *Fletcher* (M); west of Skagit River, 4 Aug., 1905, *Macoun 76795* (Cornell); Chilliwack Valley, 1 July, 1906, *Spreadborough* (Cornell and M); Skagit River, 11 July, 1905, *Macoun 76796* (Pomona).

Idaho: wet mossy spring, Smoky Mts., Blaine Co., 8000 ft. alt., 13 Aug., 1916, *Macbride & Payson 3752* (M and R. Mt.); wet

banks of alpine brook, Bonanza, Custer Co., 7000 ft. alt., 25 July, 1916, *Macbride & Payson 3419* (M and R. Mt.).

Washington: creeping over moss-covered wet rocks, especially where dripping water occurs, North Fork of Bridge Creek, Okanogan Co., Sept., 1897, *Elmer 642* (M and R. Mt.); beds of alpine rivulets, Mt. Rainier, 1892, *Allen 72* (G); moist places, glacial streams, Mt. Tacoma, 5000 ft. alt., 14 July, 1895, *Flett 168* (Cornell); Mt. Rainier, 20 Aug., 1889, *Greene* (Greene, TYPE, and Stanford); Mt. Rainier, 6000 ft. alt., 12 Aug., 1889, *E. C. Smith* (M); brooks, Nisqually Glacier, Mt. Rainier, 21 July, 1907, *Cowles 794* (M); Crater Lake, Mt. Rainier, 20 Aug., 1889, *Greene* (Stanford); Mt. Rainier, 1906, *Carpenter 52* (M); Mt. Tacoma, 1894, *E. Thompson* (Stanford); wet rocks, Mt. Paddo, 6–7000 ft. alt., 30 June, Aug., 1885, *Suksdorf 479* (G); wet rocks and stony stream banks, Mt. Paddo, 5–6000 ft. alt., 30 June–Sept., 1885, *Suksdorf* (M); Mt. Stuart, Kittitas Co., Aug., 1898, *Elmer 1280* (M and Pomona).

California: near Kearsarge Pass, Fresno Co., 11600 ft. alt., *Jepson 868* (Calif.).

13b. Var. **corallinus** (Greene) Grant, comb. nov. Pl. 9, fig. 2.

M. corallinus Greene in Erythrea **4**: 21. 1896.

M. Langsdorfii var. *Tilingi* (Regel) Greene in Jour. Bot. **33**: 8. 1895; Hall in Univ. Calif. Publ. Bot. **1**: 116. 1902.

M. veronicifolius Greene, Leafl. Bot. Obs. & Crit. **2**: 7. 1909.

M. lucens Greene, Leafl. Bot. Obs. & Crit. **2**: 7. 1909.

M. implexus Greene, Piper, Fl. Northwest Coast, 325. 1915, as to the larger plants.

Stems slender, nearly glabrous, 2–4 dm. long, internodes much elongated; leaves few, broadly ovate, oblong or suborbicular, obtuse, coarsely dentate, denticulate or somewhat sinuate, lower with longer petioles than in the species, the upper sessile, often as broad as long; stems 1–3-flowered, the flowers mostly terminal, pedicels slender, at least 2½ times the length of the calyx.

Distribution: in moist places or where water has been standing. Mountains from Wyoming and Colorado to the Pacific Coast States, southward to Lower California.

Specimens examined:

Wyoming: Garfield Peak, 29 July, 1894, *Nelson 688*, in part, (Cornell).

Colorado: Tolland, 9000 ft. alt., 8 July, 1913, *Overholts 10161* (M).

Washington: alpine rivulets, Mt. Paddo, about 7000 ft. alt., 8 Aug., 1885, *Suksdorf 472* (G).

Nevada: divide south of Slide Mt., Washoe Co., 7600 ft. alt., 5 July, 1913, *Heller 10922* (M and Stanford); branch of White's Creek, Washoe Co., 8500 ft. alt., 10 Aug., 1912, *Kennedy 1886* (G and Stanford); Washoe Mts., 25 July, 1895, *Greene* (Greene, TYPE, and N. Y.).

California: south side of Echo Lake, Eldorado Co., 11 Aug., 1916, *Heller 12539* (Cornell, M, and Stanford); Lake Tartarus, Hot Spring Valley, Plumas Co., 6800 ft. alt., 8 June, 1910, *Jepson 4086* (Calif.); along Coldstream, 3 miles above Truckee, Nevada Co., 23 July, 1903, *Heller 7004* (M, R. Mt., and Pomona); southeastern approaches to Castle Peak, Nevada Co., 31 July, 1903, *Heller* (M); summit meadows, west of Donner Pass, Placer Co., 6800 ft. alt., 26 July, 1919, *Heller 13318*, in part (Cornell); trail to Belle Meadow, Tuolumne Co., 12 July, 1915, *Jepson 6479* (Calif.); Tuolumne Grove of Big Trees, Tuolumne Co., 6000 ft. alt., 4 Aug., 1911, *Jepson 4641* (Calif.); Rancheria Mt., east of Hetch-Hetchy, 25 July, 1909, *Jepson 3406* (Calif.); Herring Creek, Tuolumne Co., 5500 ft. alt., 17 July, 1915, *A. L. Grant 112* (M); Sonora Pass Road, Tuolumne Co., 9000 ft. alt., 26 July, 1915, *A. L. Grant 136* (M); Hog Ranch near Hetch-Hetchy Valley, 4700 ft. alt., 16 June, 1917, *A. L. Grant 971* (G, U. S., Phil., Cornell, M, R. Mt., Ore., Calif. Acad., Calif., Stanford, and Pomona); Stubblefield Cañon, Yosemite Park, 8200 ft. alt., 30 July, 1911, *Jepson 4574* (Calif.); near Peregoy Meadow, Mariposa Co., 7000 ft. alt., 21 June, 1918, *A. L. Grant 1294* (Cornell, M, and Calif.); Alder Creek to Peregoy Meadow, Yosemite Park, 2 July, 1911, *Jepson 4334* (Calif.); Parker Pass, Tuolumne Co., 12000 ft. alt., 25 Aug., 1918, *A. L. Grant 1614a* (Cornell and M); along Dana Creek in Dana Meadow, Tuolumne Co., 10000 ft. alt., 25 Aug., 1918, *A. L. Grant 1614* (Cornell, U. S., M, R. Mt., Calif. Acad., Calif., Stanford, and Pomona); Jackass Meadow, Madera Co., 7000 ft. alt., 25 June,

1918, *A. L. Grant 1342* (Cornell, M, and Calif.); Mary's Meadow above Huntington Lake, Fresno Co., 7500 ft. alt., 11 July, 1917, *A. L. Grant 1081* (Cornell and M); Huntington Lake, Fresno Co., 7000 ft. alt., 5 July, 1918, *A. L. Grant 1411* (U. S., M, Calif., and Pomona); Lake of the Lone Indian, Fresno Co., 11000 ft. alt., 19 Aug., 1918, *A. L. Grant 1551* (M and Calif.); Lloyd Meadows to Little Lake, Kern River, 29 June, 1912, *Jepson 4887a* (Calif.); Mt. Goddard, 11100 ft. alt., 24–26 July, 1900, *Hall & Chandler 692* (M); edges of meadows and streamlets, Horse Corral Meadow to Summit Meadow, 7000 ft. alt., 5–15 July, 1900, *Jepson 771* (Calif.); Cottonwood Creek, Inyo Co., 10000 ft. alt., 23 July, 1912, *Jepson 5076* (Calif.); North Fork, Middle Tule, 15 Aug., 1911, *Jepson 4692* (Calif.); High Creek, Mt. San Gorgorio, 9500 ft. alt., 24 July, 1904, *G. B. Grant 6352* (M); San Jacinto Mts., 9000 ft. alt., 22 July, 1897, *H. M. Hall 709* (Stanford); Bluff Lake, San Bernardino Mts., 7400 ft. alt., 21–27 June, 1895, *Parish 3606* (Calif.); South Fork Meadows, Santa Ana Cañon, San Bernardino Mts., 8200 ft. alt., 18 July, 1906, *H. M. Hall 7508* (Pomona); Tamarack Valley, San Jacinto Mts., 9200 ft. alt., July, 1901, *H. M. Hall 2403* (M).

Mexico:

Lower California: San Pedro Martir Mts., 8000 ft. alt., 15 July, 1905, *Goldman 1237* (U. S.).

The variety *corallinus* has the same general range as the species and merges into it through such specimens as *Jepson 4085* and *5076*, *Heller 7004*, *A. L. Grant 1614*, and *Parish 3606*, all from California. Occasional plants resemble rather closely some of the more slender, few-leaved specimens of *M. guttatus* but, in general, the less erect habit, somewhat weaker stems, and the 1 to 3 terminal flowers with no visible tendency toward forming a raceme serve to separate the two.

14. **M. guttatus** DC. Cat. Hort. Monsp. 127. 1813; Fischer in Hort. Gorenk. 25. 1812, *nomen nudum;* Benth. Scroph. Ind. 28. 1835; Hook. Fl. Bor. Am. 2: 99. 1840; Hook. & Arn. Bot. Beechey's Voyage, 153 and 378. 1841; Planchon in Fl. des Serres 9: 2. 1853–54; Greene in Bull. Calif. Acad. Sci. 1:

110. 1885; Britton & Brown, Ill. Fl. **3**: 158, *fig. 3267*. 1898; Britton, Manual, 828. 1901, and ed. 2, 828. 1905; Pennell in Torreya **19**: 148. 1919. Pl. 8, fig. 4.

M. Langsdorfii J. Donn in Sim's Bot. Mag. *pl. 1501*. 1812, in synonymy; J. Donn, Hort. Cantab., ed. 7, 182. 1812, *nomen nudum;* Greene in Jour. Bot. **33**: 6. 1895; Howell, Fl. Northwest Am. 520. 1901; Nelson in Coulter & Nelson, Manual Cent. Rocky Mountains, 453. 1909; Britton & Brown, Ill. Fl., ed. 2, **3**: 190, *fig. 3777*. 1913; Piper & Beattie, Fl. Southeast Wash. and Adj. Idaho, 228. 1914; Piper & Beattie, Fl. Northwest Coast, 325. 1915; Armstrong, Western Wild Flowers, 496. 1915; Rydb. Fl. Rocky Mountains, 778. 1917; Robinson & Fernald in Gray's Manual, ed. 7, 724. 1908.

M. luteus J. Donn in Sim's Bot. Mag. *pl. 1501*. 1812, not L.; Pursh, Fl. Am. Sept. **2**: 426. 1814, not L.; Benth. in DC. Prodr. **10**: 370. 1846, in part; Gray in Bot. Calif. **1**: 567. 1876, in part; Syn. Fl. N. Am. **2**^{1}: 277. 1878, ed. 2 and Suppl. 448. 1886, in part; Wats. in Bot. King's Exp. 223. 1871; Curran in Proc. Calif. Acad. Sci. II. **1**: 263. 1888; Hall, Yosemite Fl. 221. 1912.

M. lyratus Benth. Scroph. Ind. 28. 1835; Hook. & Arn. Bot. Beechey's Voyage, 377. 1841.

M. rivularis Nutt. in Jour. Phila. Acad. Nat. Sci. **7**: 47. 1834, not Donn.

M. Scouleri Hook. Fl. Bor. Am. **2**: 100. 1840; Benth. in DC. Prodr. **10**: 371. 1846; Gray, Syn. Fl. N. Am. ed. 2, **2**^{1}: Suppl. 448. 1886; Greene in Pittonia **2**: 22. 1889; Howell, Fl. Northwest Am. 520. 1901; Piper & Beattie, Fl. Northwest Coast, 325. 1915.

M. luteus var. *gracilis* Gray in Torr. Bot. Mex. Bound. 115. 1859.

M. glabratus var. *ascendens* Gray, Syn. Fl. N. Am. ed. 2, **2**^{1}: Suppl. 448. 1886.

M. guttatus var. *grandis* Greene, Manual Bay Region, 277. 1894.

M. Langsdorfii var. *platyphyllus* Greene in Jour. Bot. **33**: 7. 1895.

M. Langsdorfii var. *argutus* Greene in Jour. Bot. **33**: 7. 1895.

M. Langsdorfii var. *grandis* Greene in Jour. Bot. 33: 7. 1895; Jepson, Fl. W. Mid. Calif. 407. 1901, and ed. 2, 379. 1911; Abrams, Fl. Los Angeles, 366. 1904, and ed. 2, 336. 1917.

M. Langsdorfii var. *californicum* Jepson, Fl. W. Mid. Calif. 407. 1901, and ed. 2, 379. 1911.

M. Langsdorfii var. *guttatus* Jepson, Fl. W. Mid. Calif. 406. 1901, and ed. 2, 379. 1911.

M. hirsutus Howell, Fl. Northwest Am. 520. 1901.

M. grandiflorus Howell, Fl. Northwest Am. 520. 1901.

M. grandis Heller in Muhl. 1: 110. 1904.

M. equinus Greene, Leafl. Bot. Obs. & Crit. 1: 189. 1905.

M. paniculatus Greene, Leafl. Bot. Obs. & Crit. 1: 190. 1905.

M. prionophyllus Greene, Leafl. Bot. Obs. & Crit. 1: 190. 1905.

M. clementinus Greene, Leafl. Bot. Obs. & Crit. 2: 5. 1909.

A glabrous or pubescent plant, annual or perennial by stems rooting at the nodes, by creeping rootstocks or by stolons; stems terete or somewhat 4-angled toward the apex, fistulous, stout and erect or weak and more or less reclining, .5–5.5 dm. high, mostly simple, commonly glabrous and puberulent or pubescent above; leaves variable, mostly rounded-ovate or ovate-oblong, sometimes broadly oblong or oblong-lanceolate, .8–15 cm. long, .6–8 cm. wide, many-nerved, coarsely and irregularly dentate, often with small projections at the base of the blade, occasionally lyrate, basal leaves often spatulate or obovate, the petioles usually much longer than the blade, upper leaves sessile, broadly rounded-ovate or suborbicular; internodes generally longer than the leaves; inflorescence mostly racemose, sometimes solitary or few-flowered, the pedicels thick and less than twice as long as the calyx, rarely slender and elongated; calyx glabrous or pubescent, campanulate, often tinged or dotted with red, 8–17 mm. long, much inflated in fruit, 1–2.5 cm. long, .8–1.5 cm. wide, teeth short, broadly triangular, sometimes mucronate, the upper tooth longer, broadly oblong, obtuse; corolla 1–4 cm. long, throat usually spotted with red, the ridges densely hairy and nearly closing the throat, margins of upper lip reflexed and much shorter than the spreading lower one; style glabrous or puberulent; capsule broadly oblong, constricted at the base or short stipitate; seeds longitudinally striate.

Distribution: common in wet places from Montana to northern Mexico, west to Alaska and California. Adventive in Connecticut and in various parts of Europe and in New Zealand.

Specimens examined:

Montana: Kranich's Grove, St. Helena, July, 1892, *Harz* (M); near Butte, 5500–6000 ft. alt., July, 1893, *Moore* (M); Spanish Creek, 15 July, 1901, *Vogel* (R. Mt.); wet ground, Gallatin River, near Bozeman, 14 July, 1905, *Blankinship 389* (M); near Red Lodge, 25 July, 1893, *Rose 13* (M); Jack Creek Cañon, 7000 ft. alt., 15 July, 1897, *Rydberg & Bessey 4945* (R. Mt.).

Wyoming: Medicine Bow Mts., Lieut. Bryan's Exp., Aug., 1856, *Engelmann* (M); Garfield Peak, 29 July, 1894, *Nelson 688*, in part (M and R. Mt.); Jackson's Hole on Snake River, 6000 ft. alt., 15 June, 1860, *Hayden* (M); Henry's Fork of Snake River, 5400 ft. alt., 18 June, 1860, *Hayden* (M); sunny, moist places, Sherman, 27 July, 1913, *Macbride 2541* (M); springy brooks, head of Middle Fork of Powder River, Big Horn Co., 19 July, 1901, *Goodding 305* (Cornell, M, and R. Mt.); Little Goose Creek, 16 July, 1896, *Nelson 2372* (R. Mt.); vicinity of Big Horn Mt., July–Aug., 1897, *Williams* (R. Mt.); on the wet bank of Trout Lake, 14 July, 1899, *Nelson & Nelson 5841* (R. Mt.); in a bog, Yellowstone River near Junction Butte, 9 July, 1899, *Nelson & Nelson 5748* (Cornell, M, and R. Mt.); North Vermilion Creek, 17 July, 1897, *Nelson 3573* (R. Mt.); swamps at Willits Spring, 28 June, 1909, *Willits 201* (R. Mt.); Centennial Valley, 17 Aug., 1895, *Nelson 1670* (Pomona); rolling plains between Sheridan and Buffalo, 3500–5000 ft. alt., 15 June–15 July, 1900, *Tweedy 3422* (R. Mt.); in a boggy stream, Bird's Eye, 25 June, 1910, *Nelson 9394* (R. Mt.); Laramie Hills, 28 June, 1891, *Buffum 704* (R. Mt.).

Idaho: Henry Lake, Fremont Co., 6000 ft. alt., 14 July, 1920, *Payson & Payson 2018* (Cornell and M); wet sand, Boise, 22 Aug., 1911, *Clark 290* (M and R. Mt.); Elk Creek, Shoshone Co., July, 1900, *Abrams 813* (Pomona); along St. Mary's River, Coeur D'Alene Mts., 26 June, 1895, *Leiberg 1071* (M and R. Mt.); Valley of North Fork of Coeur D'Alene River, 11 Aug., 1895, *Leiberg 1519* (M and R. Mt.); margins of the Blue Lakes, Twin Falls and Shoshone Falls, 25 June, 1911,

Nelson & Macbride 1344 (R. Mt.); sunny springy mountain sides, Squaw Creek, Boise Co., 3500 ft. alt., 8 May, 1911, *Macbride 808* (M); margins of hot sulphur spring bogs, Ketchum and Guyer Hot Springs, 5887 ft. alt., 22 July, 1911, *Nelson & Macbride 1278* (M); near Riverside National Park, 6000 ft. alt., 27 Aug., 1895, *Elrod* (M); Clearwater River, Nez Perces Co., May, 1896, *Heller & Heller* (Pomona); creek bank, Salmon, Lemhi Co., 4500 ft. alt., 26 June, 1920, *Payson & Payson 1791* (Cornell and M); springy places along Snake River Bluffs, 25 May, 1913, *Muenscher 375* (Cornell); wet places, June–July, 1892, *Mulford* (M); moist loam, Silver City, Owyhee Co., 15 July, 1910, *Macbride 403* (M and R. Mt.); in shallow water along river, St. Anthony, 4 July, 1901, *Merrill & Wilcox 819* (R. Mt.); Sawtooth National Forest Reservation, 1910, *Woods* (R. Mt.); wet swamps, Yellowstone National Park, 8000 ft. alt., 15 Aug., 1907, *Essig* (Pomona); sandy stream margin, Boise, 2880 ft. alt., 27 May, 1911, *Clark 26* (M and R. Mt.).

Colorado: Mt. Richtophen, 29 July, 1894, *C. F. Baker* (Pomona); Van Boxle's Ranch above Cimarron, 8000 ft. alt., 10 July, 1901, *C. F. Baker 392* (M, R. Mt., and Pomona); Cameron Pass, 10000 ft. alt., 24 July, *C. F. Baker* (Pomona); near Cañon City, 1871, *T. S. Brandegee 71* (M); headwaters of Clear Creek, 1861, *Parry 235* (M); moist hillsides, Montrose, 6000 ft. alt., 13 June, 1913, *Payson 110* (M and R. Mt.); springy places, Mammoth Gulch, Tolland, 1 Aug., 1919, *Munz 3159* (Pomona); Tolland, 31 July, 1919, *Munz 3100* (Pomona); near Breckinridge, 9700 ft. alt., 11 Aug., 1906, *Anderson* (M); moist crevices, Fish Creek Falls, 21 July, 1903, *Goodding 1650* (R. Mt.); Twin Lakes, Aug., 1873, *Wolfe 313* (Cornell); Berthoud Pass, Grand Co., 11000–12000 ft. alt., July, 1903, *Tweedy 5739* (R. Mt.); Empire, Clear Creek Co., 8500 ft. alt., 15–25 July, 1903, *Tweedy 5740* (R. Mt.); Rock Mt., Gregory Canyon, near Boulder, 20 June, 1906, *Robbins 1616* (R. Mt.); wet places, Spring Creek, 4 June, 1911, *Payson 16* (R. Mt.); Dix, 10 July, 1898, *Baker, Earle & Tracy 451* (M and Pomona); alpine streams, Hahn's Peak, Routt Co., 27 July, 1903, *Goodding 1702* (Cornell, M, and R. Mt.); streams, base of Snowy Range, 24 July, 1872, *Redfield 240* (M); Breckenridge, Summit

Co., 9600 ft. alt., Aug., 1901, *Mackenzie 352* (M); Mancos, 21 June, 1898, *Baker, Earle & Tracy 819* (M); Bob Creek, W. La Plata Mts., 10000 ft. alt., 27 June, 1898, *Baker, Earle & Tracy 181* (Cornell, R. Mt., M, and Pomona); Gray-back Mining Camps and Placer Gulch, 25–27 June, 1900, *Rydberg & Vreeland 5658* (R. Mt.).

Utah: Logan Cañon, 6 June, 1898, *Mulford* (M); Fish Lake, around Twin Creeks, 8 Aug., 1905, *Rydberg & Carlton 7621* (R. Mt.); vicinity of Clayton Peak, Wasatch Mts., 8000 ft. alt., 12–26 Aug., 1903, *Stokes* (M); streams, Wasatch Range, 1 July, 1899, *Pammell 143* (M); hills north of Salt Lake City, 12 June, 1905, *Rydberg 6177* (R. Mt.); Ogden, 29 July, 1885, *Letterman* (M); near spring in calcareous rock, Ogden Cañon, 5000–6000 ft. alt., 17 July, 1902, *Pammel & Blackwood 3706* (M); Glenwood, 5500 ft. alt., 23 May, 1875, *Ward 90* (M); Parley's Canyon, Salt Lake Co., 23 June, 1906, *Garrett 1802* (R. Mt.); Brigham, Box Elder Co., 9 May, 1910, *Zundel 192* (M); Alta, 9000 ft. alt., 19 Aug., 1902, *Cooper 404* (R. Mt.).

Nevada: Little Lakes Canyon, Elko Co., 14 July, 1902, *Kennedy 577* (M and R. Mt.); King's Cañon, Ormsby Co., 5000–6000 ft. alt., 11 June, 1902, *C. F. Baker 1060* (M, R. Mt., and Pomona); Eagle Valley, 25 June, 1859, Lieut. Bryan's Exp., *Hayden* (M); in the creeks, Las Vegas, 5 May, 1905, *Goodding 2292* (M and R. Mt.); grassy stream hummocks, Deer Creek, 1 July, 1912, *Nelson & Macbride 1842* (R. Mt.); Beattie, Nye Co., 3500 ft. alt., 5 June, 1912, *Heller 10420* (M); wet shaded places, Caliente, 24 May, 1903, *Goodding 946* (Cornell and M); wet places, Karshaw Meadow Valley Wash, 27 May, 1902, *Goodding 982* (Cornell, M, and R. Mt.); Reno, Sept., 1888, *K. Brandegee* (M).

New Mexico: 1 mile west of Hillsboro, Sierra Co., 5600 ft. alt., 1 May, 1905, *Metcalfe 1537* (M); Organ Mts., Dona Ana Co., 16 April, 1893, *Wooton* (M); Pews River, 1 Aug., 1898, *Coghill 129* (M); Bear Mt., near Silver City, Grant Co., 5000 ft. alt., 24 April, 1903, *Metcalfe 28* (M and R. Mt.); wet soil, banks of Santa Fe Creek, June-July, 1847, *Fendler 558* (M); Pleasant Valley, 29 July, 1895, *Mulford 353* (M).

Arizona: fresh running water, Beaver Dam Creek, Virgin River,

13 May, 1902, *Goodding 769* (Cornell, M, and R. Mt.); near Flagstaff, 7000 ft. alt., 8 July, 1898, *MacDougal 244* (Cornell); in water, Clifton, 5 Mar., 1881, *Rusby 321* (Cornell and M); Mt. Lemon, Santa Catalina Mts., near Tucson, 26 July, 1917, *Munz* (Cornell); near Soldiers Camp, Santa Catalina Mts., 13 July, 1916, *Harris C16309* (M); Santa Catalina Mts., 26 July, 1917, *Munz 1145* (Pomona); Pinaleno Mts., Bonita, Aug., 1917, *Munz 1219* (Pomona); Ft. Grant, Pinaleno Mts., 18 July, 1917, *Munz* (Cornell); spring, Spud Ranch, Rincon Mts., 7400 ft. alt., 2 Oct., 1909, *Blumer 3433* (M); Fossil Creek, 22 Apr., 1904, *Chamberlain 44* (U. S.); in wet sand, Pipe Spring, 5000 ft. alt., 21 May, 1894, *Jones 5272* (M); in the water's edge, Miller's Cañon, Huachuca Mts., 8 June, 1909, *Goodding 115* (R. Mt.); Barfoot Park, 8000–8250 ft. alt., 19 Sept., 1906, *Blumer 1399* (M); swamps and creeks, Fort Whipple, 6 Aug., 1865, *Coues & Palmer 103* (M); fenced area, Santa Rita Forest Reserve, 20 April, 1903, *Griffiths 4182* (M); cold springs, Price Cañon, Chiricahua Mts., 22 July, 1907, *Goodding 2299* (R. Mt.).

Alaska: Juneau, 25 July, 1899, *Trelease & Saunders 4893* (M); Kukak Bay, 5 July, 1899, *Trelease & Saunders 4897* (M); Sand Point, Unga, 7 July, 1899, *Trelease & Saunders 4896* (M); Deer Mt., Ketchikan, 2300 ft. alt., 24 Aug., 1915, *Walker & Walker 982* (M and R. Mt.); grassy beach, Tongas Village, Portland Canal, 3 Aug., 1915, *Walker & Walker 885* (M and R. Mt.); near timber line, Kuiu Island, Port Malmosburg, 3 July, 1915, *Walker & Walker 778* (M and R. Mt.); river margins, Glacier River, Unalaska, 2 July, 1907, *Van Dyke 146* (G); Akutan, 21 Aug., 1907, *Van Dyke 321* (G); Sitka, 1865–66, *Bischoff* (G and Cornell); Bay, Sitka, 5 Aug., 1907, *Cowles 1305* (M); Kadiak Island, 1 July, 1899, *Trelease & Saunders 4894* (M); Kadiak Island, 2–4 July, 1899, *Fernow* (Cornell); Dutch Harbor, Unalaska, 6 July, 1907, *Van Dyke 27* (G); Nazan Bay, Atka, 26 July, 1907, *Van Dyke 245* (G); Yukatat Bay, 14 July, 1892, *Funston 55* (G, Cornell, and M).

British Columbia: on rocks along shore, June–July, 1901, *Rosendahl & Brand 6* (M, R. Mt., and Pomona); swamp at Howser Lake, 2000 ft. alt., 23 June, 1905, *Shaw 778* (M); Chilliwack

Valley, 29 June, 1901, *Macoun 54480* (M); Chilliwack Valley, 20 July, 1906, *Spreadborough* (Cornell); near Sproat Lake, 400 ft. alt., 26 June, 1907, *Rosendahl 1929* (M); North Fork of Illecillewaet, 3500 ft. alt., 26 Aug., 1904, *Shaw 567* (M); vicinity of Victoria, 19 May, 1893, *Macoun 702* (M); near mouth of Downie Creek, 1900 ft. alt., 9 Aug., 1905, *Shaw 1113* (M); wet place near Revelstoke Station, 1600 ft. alt., 9 July, 1905, *Shaw 857* (M); Mt. Finleyson, Vancouver Island, 18 May, 1887, *Macoun* (Cornell); vicinity of Ucleulet, Vancouver Island, 12 May, 1909, *Macoun 87665* (M).

Washington: Fresh Lake, Grand Coulee, 2 July, 1902, *MacKay 11* (M); Soap Lake, 28 June, 1902, *MacKay 17* (M); Clallam, Aug., 1900, *Elmer 2583* (M); in ditch, Northwood Swamp, Whatcom Co., July, 1919, *Muenscher 5070* (Cornell); near Montesano, Chehalis Co., 200 ft. alt., 29 June, 1898, *Heller & Heller 3986* (G, Cornell, M, and Pomona); near Montesano, Chehalis Co., 2 July, 1898, *Heller & Heller 4006*, in part (Cornell and M); growing in an old slough bed, Pleasant Ridge, Skagit Co., 4 Aug., 1918, *Roush 5* (M and Cornell); in moist places, Cold Creek, Yakima Region, 1 June, 1901, *Cotton 394* (M and R. Mt.); swamps and springs, Puyallup, 5 Aug., 1897, *Flett 161* (Cornell); Seattle, July, 1915, *Freiberg* (M); common in wet places, Seattle, 8 Oct., 1910, *Zeller* (M); Kanaka Bay, San Juan Islands, 25 June–1 Aug., 1917, *Zeller & Zeller 946* (M); McNeil's Island, 9 May, 1896, *Flett 34* (Cornell); Gray's Harbor City, 15 May, 1897, *Lamb 1065* (M); damp low ground, Klickitat River near Mt. Paddo, 26 June, 1885, *Suksdorf 478* (G); damp or wet places, W. Klickitat Co., 20 April, 1885, *Suksdorf* (M); along streams, W. Klickitat Co., 17 June, 1892, *Suksdorf 2136* (M); wet meadows, Falcon Valley, 2 July, 1885, *Suksdorf 473* (G); springs in woods, Falcon Valley, 31 July, 1885, *Suksdorf 474* (G); Argyle, 24 June, 1912, *Zeller* (M); Bog, Mt. Constitution, 5 July, 1907, *Cowles 362* (M); Nason Creek, 2150 ft. alt., 30 July, 1893, *Sandberg & Leiberg 618* (M); along the Tukanon River, 1 July, 1892, *Lake & Hull* (M); Coulee City, Douglas Co., 6 Aug., 1892, *Hull* (M); Newman Lake, Aug., 1913, *Turesson 27* (R. Mt.); 6 miles south of Pullman on Union Flat, 9 July, 1901, *Piper* (Pomona).

Oregon: wet situations, eastern Oregon, 29 June, 1899, *Cusick 2206* (Cornell and M); Horse Creek Cañon, Wallowa Co., 1775 ft. alt., 24 May, 1897, *Sheldon 8146* (M); The Dalles, Wasco Co., 5 April, 1902, *Sheldon S10034* (M); in a creek between Portland and Rex, 26 July, 1918, *Roush 1* (Cornell, M, and Stanford); Queen's Branch, Jackson Co., 18 June, 1892, *Hammond 311* (M); John Day near Tongue Point, Clatsop Co., 20 Aug., 1902, *Sheldon S11196* (M); near camp at Hasbrook Gulch, 4700 ft. alt., 15 July, 1897, *Sheldon 8580* (M); Tuolitin River, Clackamas Co., 23 Aug., 1903, *Sheldon S13006* (Stanford); shore of Columbia River above Astoria, 1883, *Meehan* (M); McGribble Ranger Station, 10 miles southeast of Port Oxford, 1 July, 1919, *Peck 8625* (M); St. Helen, May, 1887, *Howell 1244* (M); near Marshfield, Coos Co., 1 Sept., 1912, *House 4978* (U. S.); rocks on Umqua River, 11 Aug., 1880, *Engelmann* (M).

California: California, 1833, *Douglas* (K and G); ridges and meadows near Marble Mt., Siskiyou Co., 5000 ft., June, 1901, *Chandler 1694* (M); near Durney's Mill, in moist open places, Siskiyou Co., 30 June, 1919, *Heller 13284* (Cornell and M); wet places near Yreka, 29 May, 1910, *Butler 1423* (M and R. Mt.); near Yreka, 24 April, 1876, *Greene* (M); Shasta Springs, Siskiyou Co., 13 June, 1905, *Heller 8027* (M); Compton's Prairie, north base of Mt. Eddy, Siskiyou Co., 25 June, 1919, *Heller 13271* (Cornell and M); Metcalf's Ranch, northeast base of Mt. Eddy, 3800 ft. alt., 6 July, 1920, *Heller 13417* (M); Mt. Bidwell, Modoc Co., 5900 ft. alt., 7 Aug., 1918, *Jepson 7853* (Calif.); Jess Valley, Modoc Co., 5200 ft. alt., 12 Aug., 1918, *Jepson 7955* (Calif.); at Sisson's, Mt. Shasta, 25 Aug., 1880, *Engelmann* (M); marshy meadows, Sisson, 1894, *Jepson 21m* (Calif.); Sisson, 13 Aug., 1903, *Copeland*, distributed as *C. F. Baker 3808* (Pomona); Quincy, 3500 ft. alt., 16 June, 1910, *Jepson 4142* (Calif.); Prattville, Plumas Co., 11 July, 1907, *Heller & Kennedy 8794* (M); Bear Valley, Nevada Co., 4500 ft. alt., July, 1898, *Jepson 2m* (Calif.); springy woods, Fallen Leaf Lake, 27 June, 1920, *Ottley 900* (Wellesley, Cornell, and M); Penn Valley, Nevada Co., 24 May, 1919, *Heller 13191* (M); Truckee, July, 1886, *Sonne 267* (M); Blue Cañon, Sept.,

1888, *K. Brandegee* (Cornell and M); 8 miles north of Oroville, 13 March, 1914, *Heller 11200* (M); near Oroville, Butte Co., 4 May, 1915, *Heller 11868* (Cornell and M); about springs on lava fields, Chico, Butte Co., 2 May, 1903, *Copeland*, distributed as *C. F. Baker 3017* (M and Pomona); Butte Meadows, Butte Co., 4200 ft. alt., 26 July, 1917, *Heller 12813* (Cornell and M); Chico Meadows, Butte Co., 4000 ft. alt., 22 June, 1914, *Heller 11492* (Cornell); near Clear Creek, Butte Co., 175 ft. alt., 1–15 May, 1897, *H. E. Brown 169* (M and R. Mt.); Table Mt., Olive Ranch north of Oroville, Butte Co., 23 May, 1912, *Heller 10755* (M); Berry Canyon, Butte Co., 8 May, 1902, *Heller & Brown 5493* (M); Alder Springs, Glenn Co., 4 July, 1917, *Heller 12771* (M); Big Horse Mt., South Fork of the Eel River, July–Aug., 1892, *Jepson 14m* (Calif.); summit of Yuba Pass, July, 1913, *Ames 18* (Calif.); base of South Butte, 20 April, 1891, *Jepson 15m* (Calif.); White Bar, Amador Co., 1000 ft. alt., May, 1895, *Hansen 1050* (M); New York Falls, Amador Co., 1500 ft. alt., 3 June, 1896, *Hansen 2053* (M); West Point Bridge, Calaveras Co., 2300 ft. alt., 7 July, 1896, *Hansen 1801* (M); Gwin Mine, Calaveras Co., 12 May, 1902, *Jepson 1812* (Calif.); French Camp, Tuolumne Co., 3000 ft. alt., 14 May, 1915, *A. L. Grant 5* (M); Phoenix Lake, near Sonora, Tuolumne Co., 20 May, 1917, *A. L. Grant 948* (G, U. S., Cornell, M, R. Mt., Ore., Calif., Calif. Acad., Stanford, and Pomona); Chinese Camp, Tuolumne Co., 30 May, 1915, *Jepson 6326* (Calif.); Hog Ranch, near Hetch-Hetchy Valley, 4700 ft. alt., 16 June, 1917, *A. L. Grant 969* (Cornell, M, Calif., and Pomona); Yosemite Valley, 13 June, 1891, *Fritchey 39* (M); wet meadow to Mirror Lake, Yosemite, 23 June, 1894, *Burnham* (Cornell); Fish Camp, Mariposa Co., 29 June, 1919, *Jepson 8397* (Calif.); Raymond, Madera Co., 9 June, 1894, *Burnham* (Cornell); Hart's Meadow, Madera Co., 23 June, 1918, *A. L. Grant 1309c* (Cornell, M, and Calif.); meadow near Fresno Dome, Madera Co., 23 June, 1918, *A. L. Grant 1309b* (Cornell, M, and Calif.); Arnold Meadow, Madera Co., 5000 ft. alt., 27 June, 1918, *A. L. Grant 1378* (Cornell, M, and Calif.); near Milo, Fresno Co., 24 April, 1919, *Goetz 5* (M); wet meadow, Pine Ridge, Fresno Co., 4700 ft. alt., 24 June,

1917, *A. L. Grant 1004* (G, Phil., Cornell, Calif., Stanford, and Pomona); stream-sides, Dinkey Ranger Station, Fresno Co., 5000 ft. alt., 29 July, 1917, *A. L. Grant 1181* (Cornell, M, Calif., Stanford, and Pomona); Huntington Lake, Fresno Co., 7000 ft. alt., 16 July, 1917, *A. L. Grant 1093* (N. Y., U. S., Cornell, M, R. Mt., and Calif.); Bakersfield, Kern Co., 6 May, 1905, *Heller 7838* (M); Weldon, Kern Co., 19 April, 1915, *Evermann* (M); Thorp's Meadow, Giant Forest, 3 Aug., 1900, *Dudley 3009* (Stanford); sloughs near Hanford, 24 June, 1901, *Kearney* (M); Middle Fork King's River, July, 1913, *Eliot* (Calif.); river's edge, Marble Fork, Sequoia National Park, 5800 ft. alt., 24 June–2 July, 1900, *Jepson 687* (Calif.); South Fork, Kaweah River, Tulare Co., 22 July, 1904, *Culbertson*, distributed as *C. F. Baker 4292* (M and Pomona); Natural Bridge Meadows, Tulare Co., 10 Aug., 1904, *Culbertson*, distributed as *C. F. Baker 4259* (M and Pomona); in ditch, Fales Hot Springs, Mono Co., 7 July, 1920, *Ottley 1116* (Wellesley and Cornell); Silver Canyon in the White Mts., east of Laws, Inyo Co., 29 May, 1906, *Heller 8343* (M); Bishop, Inyo Co., June, 1917, *Nordyke* (Cornell); Shepherd's Cañon, Argus Mts., 6000 ft. alt., Death Valley Expedition, 28 April, 1891, *Coville & Funston 740* (Cornell and M); near Comptche, Mendocino Co., 23–29 June, 1906, *Walker 383* (Pomona); Willits, 1400 ft. alt., 26 May, 1905, *Jepson 2503* (Calif.); springy bank above stream near the ocean, Fort Bragg, 25 June, 1921, *Ottley 1525* (Wellesley and Cornell); near Mendocino, June, 1898, *H. E. Brown 842* (M); Indian Valley, Lake Co., 23 May, 1920, *Jepson 8994* (Calif.); Cache Creek, Lake Co., 10 May, 1919, *Heller 13147* (Cornell and M); in the 'Horse Pasture,' near the summit of Mt. Sanhedrin, Lake Co., 20 July, 1902, *Heller 5924* (Cornell, Greene, M, R. Mt., and Pomcna); Howell Mt. foothills, Napa River Basin, 24 April, 1893, *Jepson 4m* (Calif.); tule land near Dunnigan, 20 April, 1917, *Ferris 699* (M); Howell Mt., Sept., 1888, *K. Brandegee* (M); Vacaville, 20 Mar., 1901, *Jepson 1198a* (Calif.); Stewart's Cañon, near Falls, Sonoma Co., May, 1899, *M. S. Baker* (Pomona); Calistoga, Napa Co., 19 April, 1903, *C. F. Baker 1980* (M); near Ocean View, San Francisco, 8 June, 1906,

Heller 8376 (M); vicinity of Lake Merced, San Francisco Peninsula, May, 1903, *Gardner 567* (R. Mt.); on beach, San Francisco, 8 Aug., 1915, *Drushel* (M); sand hills near Cliff House, San Francisco, 14 March, 1902, *C. F. Baker 312* (Pomona); Berkeley Hills, 22 May, 1910, *Jepson 4043* (Calif.); Woodside, San Mateo Co., 4 May, 1902, *Abrams 2422* (M); Crystal Springs Lake, San Mateo Co., April, 1903, *Elmer 4857* (M and Pomona); Woodside, San Mateo Co., 4 May, 1902, *C. F. Baker 759* (M and Pomona); hills near Pescadero, San Mateo Co., 6 May, 1917, *A. L. Grant 942* (Cornell); Bell's Station, Pacheco Pass, 4 June, 1894, *Burnham* (Cornell); San Jose Hills, April, 1897, *Wislizenus 761* (M); along the Mt. Hamilton Road, 20 May, 1904, *Heller 7433* (M and R. Mt.); Smith Creek, foot of Mt. Hamilton, 10 May, 1907, *Heller 8517* (M); Santa Cruz, 1 July, 1903, *C. H. Thompson* (M); on the Carmel Road near Monterey, 9 June, 1903, *Heller 6829* (M, R. Mt., and Pomona); wet sand near Carmel River, Monterey Co., 2 May, 1921, *Ottley 1271* (Wellesley and Cornell); bluffs of the seashore, Pacific Grove, Aug., 1917, *Parish 11567* (M); Mohave River, Barstow, 2100 ft. alt., 7 June, 1912, *Jepson 4812* (Calif.); vicinity of Bonanza King Mine, Mohave Desert, 4000 ft. alt., 21–24 May, 1920, *Munz, Johnston & Harwood 4031*, in part (M and Pomona); Los Angeles River, Los Angeles Co., 8 April, 1901, *Abrams 1442* (Pomona); Acton, Los Angeles Co., June, 1902, *Elmer 3645* (M); San Gabriel Wash, Los Angeles Co., 12 May, 1920, *Ottley 681* (Wellesley and Cornell); Eaton Cañon, San Gabriel Mts., 2100 ft. alt., 1 June, 1918, *Pierson 198* (Calif.); Avalon, Santa Catalina Island, May, 1906, *Trask* (M); Santa Catalina Island, 21–26 April, 1904, *Grant & Wheeler 6135* (M and R. Mt.); hills near Claremont, 12 Aug., 1903, *C. F. Baker 3460* (Pomona); near stream, Bear Flats, mountains above Claremont, 30 June, 1915, *Crawford* (M and Pomona); wet springy place in South Hills, Pomona, 19 May, 1918, *Munz 2266* (Cornell and Pomona); San Clemente Island, June, 1903, *Trask 342* and *343* (U. S.); Hemet, Riverside Co., 5 April, 1904, *C. F. Baker 4142* (Pomona); cement standpipe of irrigation ditch, Ohio Ave., Riverside, 5 Jan., 1920, *Barrus 71* (Cornell); swampy ground, Red

Hill near Upland, San Bernardino Co., 28 April, 1917, *I. M. Johnston 1204* (Pomona); near San Bernardino, May, 1894, *Parish* (Calif.); borders of Warm Creek, San Bernardino Valley, about 900 ft. alt., 14 May, 1917, *Parish 11191* (M and Pomona); Bluff Lake, San Bernardino Mts., 5 Sept., 1915, *Gardner 513* (Pomona); City Creek, San Bernardino Mts., 5 June, 1911, *Parish 11311* (M and Pomona); Mill Creek Cañon, San Bernardino Mts., May, 1913, *Jepson 5569* (Cornell and M); Idyllwild, San Jacinto Mts., 5300 ft. alt., 1921, *Spencer 1709* (Pomona); San Diego, 1874, *Cleveland* (M); borders of Cuyamaca Lake, San Diego Co., 25 June, 1903, *Abrams 3877* (M); southwestern part of Colorado Desert, San Diego Co., April, 1889, *Orcutt* (M); meadow at Jacumba, San Diego Co., 13 Aug., 1917, *Munz* (Cornell); Del Mar, San Diego Co., 4 May, 1895, *Angier 192* (M); San Luis Rey, San Diego Co., 10 May, 1882, *Orcutt 134* (M); Bubbling Spring, Collins Valley, 28 April, 1920, *Jepson 8833* (Calif.).

Mexico:

Lower California: near Encenada de Todas Santos, northern Lower California, 13 July, 1885, *Orcutt* (M).

Chihuahua: near Colonia Juarez, June–July, 1899, *E. W. Nelson 6027* (G); vicinity of Chihuahua, about 4000 ft. alt., 8–27 April, 1908, *Edw. Palmer 16* (M); vicinity of Madera, about 6750 ft. alt., 27 May–3 June, 1908, *Edw. Palmer 289* (M); vicinity of Chihuahua, about 4000 ft. alt., 1–21 May, 1908, *Edw. Palmer 145* (M); vicinity of Chihuahua, 8–27 April, 1908, *Edw. Palmer 17* (M); near Colonia Garcia in the Sierra Madres, 9 June, 1899, *Townsend & Barber 28* (G, M, and R. Mt.); river gravel, Chihuahua, 14 April, 1886, *Pringle 889* (M).

This species is the most common and the most polymorphic in the genus. It varies greatly with environmental conditions, especially in relation to the size of the stem, leaves, and flowers. In several experiments, plants were marked early in the season which had corollas 3.5–4.5 cm. long; late in the summer, flowers produced on these same plants were less than half that length. The variety *grandis* of Greene is therefore considered to be a direct response to environment, the size of the parts being dependent on the amount of water available or on the vitality of the plant.

In general, *M. guttatus* may be separated from the other members of the genus by its stout fistulous stems, its rounded leaves with the blade often as broad as long, its racemose inflorescence in which the floral leaves are mostly reduced to small bracts, and by its stout pedicels, commonly shorter than the flowers. Many species and varieties have been separated from this aggregate and of these only the following seem worthy of varietal distinction. Some show so many intermediates that it has been with considerable hesitation that such varieties as *depauperatus* and *puberulus* are retained. The writer feels, however, that their retention will lead to greater clearness.

14a. Var. **puberulus** (Greene) Grant, comb. nov.

M. puberulus Greene, acc. to Rydb. Fl. Colo. 311. 1906, *nomen nudum;* Greene, Leafl. Bot. Obs. & Crit. **2**: 4. 1909; Woot. & Standl. Contr. U. S. Nat. Herb. **19**: 587. 1915; Rydb. Fl. Rocky Mountains, 778. 1917.

Perennial; stems erect, densely pubescent above, often freely branched from the base; leaves broadly ovate or elliptical, 1–4 cm. long, acute or obtuse, puberulent or pubescent, usually grayish-green; pedicels shorter than the flowers, sometimes recurved in fruit; corolla 2–3 cm. long.

Distribution: in wet places in southern Colorado and northern New Mexico.

Specimens examined:

Colorado: Pagosa Springs, 27 July, 1899, *C. F. Baker 587* (U. S., Greene, TYPE, M, R. Mt., and Pomona); Keating, Fremont Co., without date, *Comstock* (Cornell); near Boulder, 9 June, 1900, *Ramaley 115* (R. Mt.).

New Mexico: mouth of Pouchuelo Creek, Pecos River National Forest, 8500 ft. alt., 30 June, 1908, *Standley 4089* (M).

14b. Var. **depauperatus** (Gray) Grant, comb. nov.

M. luteus var. *depauperatus* Gray in Bot. Calif. **1**: 567. 1876; Syn. Fl. N. Am. **2**[1]: 277. 1878, ed. 2, and Suppl. 448. 1886; Henry, Fl. Brit. Columbia, 268. 1915.

M. microphyllus Benth. in DC. Prodr. **10**: 371. 1846; Greene in Bull. Calif. Acad. Sci. **1**: 111. 1885; Howell, Fl. Northwest

Am. 521. 1901; Abrams, Fl. Los Angeles, 367. 1904, and ed. 2, 337. 1917; Rydb. Fl. Rocky Mountains, 779. 1917.

M. tenellus Nutt. ex Gray, Proc. Am. Acad. **11**: 98. 1876.

M. thermalis Nels. in Bull. Torr. Bot. Club **27**: 269. 1900; Rydb. Fl. Rocky Mountains, 779. 1917.

M. longulus Greene, Leafl. Bot. Obs. & Crit. **2**: 4. 1909.

M. Langsdorfii var. *microphyllus* Nels. & Macbr. in Bot. Gaz. **61**: 44. 1916.

M. puncticalyx Gdgr. in Bull. Soc. Bot. Fr. **19**: 219. 1919.

Annual; stem erect, 3–25 cm. high, mostly simple, slender, glabrous or pubescent, 4-angled; internodes long, leaves few, thin, orbicular or broadly ovate, 1–3.5 cm. long, 1–1.5 cm. wide, obtuse, denticulate to irregularly dentate, sometimes lyrate or with the margins nearly entire, lower leaves with petioles nearly as long as the blade; flowers solitary or in a short raceme, pedicels slender, frequently recurved when mature; calyx campanulate, often dotted or tinged with red, glabrous or puberulent, subglobose in fruit, 5–12 mm. long, 4–8 mm. wide, teeth short, broadly deltoid, obtuse or acute, the upper tooth about twice as long as the others, throat much constricted, giving an elliptical appearance; corolla from 1½ to 3 times the length of the calyx; style glabrous; capsule stipitate.

Distribution: in wet places in the mountains from Wyoming and Idaho to Washington, south to California.

Specimens examined:

Wyoming: on geyser formations, Upper Geyser Basin, 3 Aug., 1899, *Nelson & Nelson 6285* (M and R. Mt.); Upper Geyser, Yellowstone Park, without date, *Broadhead* (M); Mineral Hot Springs, Yellowstone Park, July, 1904, *Oleson 15* (R. Mt.); Fire Hole, Yellowstone Park, July, 1904, *Oleson 22* (R. Mt.); on the "formations" and frequent in Yellowstone Park, 16 July, 1912, *Churchill* (M).

Idaho: gravelly wet places, Squaw Butte, Canyon Co., 3500 ft. alt., 29 May, 1910, *Macbride 143* (R. Mt.); margins of hot sulphur spring bogs, Ketchum and Guyer Hot Springs, 22 July, 1911, *Nelson & Macbride 1278* (R. Mt.); very moist meadow east of Bennington, 4 Aug., 1913, *Schoper 17* (R. Mt.).

Nevada: King's Cañon, Ormsby Co., 11 June, 1902, *C. F. Baker 1058* (M, R. Mt., and Pomona).

Washington: Kanaka Bay, San Juan Islands, 25 June–1 Aug., 1917, *Zeller & Zeller 947* (M); Loon Lake, Stevens Co., 29 June, 1913, *Turesson 26* (R. Mt.); wet, rocky places on mountain-sides near Bingen, W. Klickitat Co., 21 April–17 June, 1896, *Suksdorf 2773* (M); on damp ground, W. Klickitat Co., 3 Aug., 1894, *Suksdorf 2321* (M).

Oregon: Hood River on the Columbia, 1885, *Barrett* (G); near summit of Mt. Scott, 5000 ft. alt., 21 July, 1899, *Barber 11* (G); Drew's Valley Creek, Lake Co., 4 Aug., 1897, *Austin 1543* (U. S.); St. Helen, Aug., 1913, *von Schrenk* (M); wet bank, Riddle, Douglas Co., 4 Aug., 1916, *Peck 5606* (G); Crater Lake National Park, 20 July, 1918, *Heller 13061* (M and Cornell); Seaside, July, 1922, *Epling 5551* (Epling).

California: plains east of Chico, Butte Co., April, 1896, *Austin 85* (M); Webber Lake, 8 July, 1901, *Kennedy & Doten 118* (R. Mt.); lower end of Donner Lake, 8 Aug., 1903, *Heller 7163* (M); Table Mt., Tuolumne Co., 9 June, 1915, *Jepson 6429* (Calif.); Table Mt., near Columbia, 9 June, 1915, *A. L. Grant 15m* (Cornell and M); near Cherry Creek on the trail to Lake Eleanor, 12 June, 1918, *A. L. Grant 1231* (Cornell and M); Hetch-Hetchy to Hog Ranch, 30 July, 1909, *Jepson 3482* (Calif.); Hetch-Hetchy Valley, 4700 ft. alt., 14 June, 1917, *A. L. Grant 977* (Cornell, M, and Calif.); Yosemite Creek Trail, 18 June, 1918, *A. L. Grant 1290* (Calif.); Ranger's Cabin at Hog Ranch, above Hetch-Hetchy Valley, 4700 ft. alt., 10 June, 1916, *A. L. Grant 803* (Cornell and M); Little Kern River, near Trout Meadows, 29 June, 1912, *Jepson 4909* (Calif.); in the foothills west of Bishop, Inyo Co., 23 May, 1906, *Heller 8323* (M); in wet moss, Idyllwild, San Jacinto Mt., 5400 ft. alt., 22 June, 1921, *Spencer 1671* (Pomona).

14c. Var. **Hallii** (Greene) Grant, comb. nov.

M. Hallii Greene in Bull. Calif. Acad. Sci. **1**: 113. 1885; Nelson in Coulter & Nelson, Manual Cent. Rocky Mountains, 454. 1909; Rydb. Fl. Rocky Mountains, 779. 1917.

A small glabrous annual, .5–2.5 cm. long; stem erect or nearly so; leaves light green, rounded, irregularly denticulate, sometimes almost entire; pedicels slender, longer than the leaves, erect or

ascending; mature calyx much inflated, subglobose, sometimes sparingly spotted with red, teeth broadly triangular, acute, upper tooth longer than the others, all folded toward the center when mature; corolla little longer than the calyx.

Distribution: wet places in the mountains of Idaho, Colorado, and Nevada.

Specimens examined:

Idaho: wet woods, Hot Hole, East Fork Bruneau, Owyhee Co., 3 July, 1912, *Nelson & Macbride 1908* (G, M, and R. Mt.).

Colorado: Rocky Mt. Flora, Lat. 39°–41°, 1862, *Hall & Harbour 398* (M, *type collection*); stream, Boulder, 5700 ft. alt., 20 June, 1906, *Daniels 25* (M); Boulder, 10 June, 1901, *Wheeler 313* (R. Mt.); mouth of Boulder Cañon, 3 June, 1901, *Ramaley 707* (R. Mt.); Sunshine Canyon, near Boulder, 19 June, 1906, *Robbins 1599* (R. Mt.); damp places, Georgetown, 8500 ft. alt., 18 July, 1892, *Patterson 294* (M); Piedra, 14 July, 1899, *C. F. Baker 588* (G, M, R. Mt., and Pomona).

Nevada: Lone Mountain, Elko Co., 7000 ft. alt., 5 Aug., 1913, *Kennedy 4356* (Stanford); Star Canyon, southeast of Deeth, Elko Co., 5600 ft. alt., 10 July, 1912, *Heller 10569* (M and Stanford).

14d. Var. **decorus** Grant[1] Pl. 4, fig. 1.

A tall glabrous perennial, stem 2–10 dm. high; leaves few, broadly ovate, 2–6 cm. long, 2–3 cm. wide, acute, coarsely and doubly dentate, 5–7-nerved, cordate to almost truncate at the base, petioled, floral leaves sessile, internodes very long; pedicels stout, shorter than the corolla; calyx broadly campanulate, teeth short, broad, acute, the upper longer; corolla 3–4.5 cm. long, tube short, throat ventricose, dotted with red on the lower side; style minutely pubescent.

Distribution: wet places in Washington and Oregon.

Specimens examined:

Washington: Mt. Tacoma, without date, *Flett 9* (Cornell); near Montesano, Chehalis Co., 200 ft. alt., 2 July, 1898, *Heller &*

[1] **Mimulus guttatus** DC. var. **decorus** Grant, var. nov., perennis altus; foliis late-ovatis, acutis, crasse et dupliciter dentatis, petiolo brevi; pedunculis robustis corolla brevioribus; corolla 3–4.5 cm. longa.—Collected in the vicinity of Oregon City, Oregon, June 11, 1905, *M. W. Lyon, Jr. 59* (Mo. Bot. Gard. Herb., no. 866366, TYPE).

Heller 4006 (R. Mt. and Pomona); in Moss Creek near Chenowith, Skamania Co., 8 July, 12 Aug., 1896, *Suksdorf 2774* (M); Skokomish Valley, Mason Co., 11 June, 1892, *Henderson* (M).
Oregon: along a mountain stream, Portland, 3 July, 1903, *Lunell* (R. Mt.); wet meadow, vicinity of Oregon City, 11 June, 1905, *Lyon 59* (M, TYPE); swampy ground, Calapooya Valley, 3500 ft. alt., 17 July, 1899, *Barber* (R. Mt.); Oregon, June, 1881, *Dickson 6396* (M); Oregon, 1871, *E. Hall 374* (M and G).

14e. Var. **arvensis** (Greene) Grant, comb. nov. Pl. 10, figs. 7–9.

M. arvensis Greene, Pittonia 1: 37. 1887; Manual Bay Region, 277. 1894.

M. Langsdorfii var. *arvensis* Jepson, Fl. W. Mid. Calif. 407. 1901, and ed. 2, 379.. 1911.

M. marmoratus Greene in Erythea 3: 73. 1895.

Annual, stem and branches nearly glabrous, internodes elongated; lower leaves rounded-ovate or oblong, long-petioled, more or less lyrate, floral leaves sessile, usually villous on the lower surface; upper calyx-tooth not markedly longer than the others, giving a short stubby, almost truncate appearance when mature; calyx slightly constricted at the throat, the teeth rarely folded over each other; corolla 1–3 cm. long.

Distribution: wet places in the foothills and valleys of central California.

Specimens examined:

California: Ukiah Valley, 2 June, 1921, *Jepson 9285* (Calif.); in rich moist loam, valley west of Leesville, Colusa Co., 10 May, 1919, *Heller* (M); between Shingle Springs and El Dorado, Eldorado Co., 7 April, 1911, *Heller 12299* (Cornell and M); New York Falls, Amador Co., April, 1895, *Hansen 1048* (M); Agricultural Station, Amador Co., May, 1892, *Hansen 1287* (M); on moist rocks, Knight's Ferry, Stanislaus Co., 9 April, 1895, *Bancroft* (Greene); Hog Ranch, Yosemite Park, 3 Aug., 1911, *Jepson 4628* (Calif.); Yosemite Valley near the Royal Arches, 28 June, 1919, *Jepson 8370* (Calif.); near Comptche, Mendocino Co., 23–29 June, 1906, *Walker 347* (Pomona); near Windsor, Sonoma Co., 18 April, 1902, *Heller & Brown 5331* (Cornell and M); Santa Rosa Creek, east of Santa Rosa,

Sonoma Co., 11 June, 1902, *Heller 5687* (Cornell, M, and Pomona); Calistoga, 6 May, 1921, *Jepson 9171* (Calif.); trail to Caux's Cabin, Hood's Peak Range, west of St. Helena, 25 April, 1893, *Jepson 11m* (Calif.); hills east of St. Helena, 23 April, 1915, *Jepson 6238* and *6238a* (Cornell, M, and Calif.); Howell Mt., Napa River Basin, 8 May, 1893, *Jepson 10m* (Calif.); West Berkeley, 25 April, 1891, *Jepson 1m* (Calif.); Berkeley, May–June, 1906, *Walker 440* (Pomona); San Mateo, 21 April, 1894, *Burnham* (Cornell); Stanford University, 25 April, 1902, *Abrams 2370* (M); summit of the first ridge west of Los Gatos, 9 May, 1904, *Heller 7393* (M and R. Mt.); near Burke's Ranch, Stanford University, 13 April, 1894, *Burnham* (Cornell and Pomona).

In general, this variety can be distinguished by its short, somewhat truncate mature calyx, its long-petioled, more or less lyrate lower leaves, and the sessile floral ones, which are white-villous below. The corolla, usually, is much smaller than in the species. The same characters will generally separate it from the var. *depauperatus* with which it might be confused.

15. **M.** glaucescens Greene in Bull. Calif. Acad. Sci. **1**: 113. 1885; Gray, Syn. Fl. N. Am. ed. 2, 2^1: Suppl. 448. 1886.

Mostly glabrous and glaucous annuals; stem erect, .5–4 dm. high, simple or branched, terete, occasionally quadrangular above; lower leaves bright green, round-ovate or subcordate, 2–10 cm. long, 3–5-nerved from the base, coarsely and irregularly toothed, occasionally lobed at the base, petioles slender, as long as or much longer than the blade, sometimes pubescent or villous, upper leaves few, sessile, orbicular, about as broad as long, becoming connate-perfoliate below the flowers, more or less conspicuously glaucous, nearly entire or with small scattered teeth; pedicels commonly about as long as the mature calyx, occasionally twice as long, stout, strongly recurved; calyx broadly campanulate, 1.1–1.3 cm. long, at maturity 1.5–2 cm. long, 9–11 mm. broad, teeth short, broadly triangular, blunt, the upper slightly longer, the lower folding over the lateral teeth and closing the orifice, densely villous with soft white hairs at the sinuses; corolla 2–3.5 cm. long, lower lip spreading, bearded, more or less

spotted with red; style puberulent, slightly exserted; capsule oblong, short-stipitate, more than half as long as the calyx; seeds reticulate.

Distribution: local in the foothills in Nevada Co., in Tehama Co., and in the northern part of Butte Co., California.

Specimens examined:

California: 8 miles south of Vina in wet sand, edge of Pine Creek, Tehama Co., 29 April, 1914, *Heller 11340* (Cornell, F, and Greene); Berry Canyon, near Clear Creek, Butte Co., 6 May, 1902, *Heller & Brown 5461* (Cornell, F, M, R. Mt., and Pomona); Chico, Butte Co., March, 1899, *Copeland* (Stanford); Little Chico Creek, Butte Co., April, 1883, *Austin 213* (Greene, Calif. Acad., TYPE, and Calif.); Little Chico Canyon, Butte Co., 1896, *Austin 159* (M); Chico, Butte Co., 15 May, 1903, *Copeland 3177*, distributed as *C. F. Baker 3177* (M, F, R. Mt., and Pomona); Cañon of Big Chico Creek, Butte Co., 2 July, 1914, *Heller* (M); Butte Co., June, 1889, *Parry* (M); low ground, 12 miles north of Chico, 29 April, 1914, *Heller 11340a* (M); Chico Creek, April, 1885, *Gray* (G); Chico, June, 1890, *Greene* (Greene); Penn Valley, west of Grass Valley, Nevada Co., 24 May, 1919, *Heller 13191* (Cornell).

M. glaucescens is unique in the genus by reason of its glaucous, connate-perfoliate upper leaves.

16. **M. nudatus** Curran ex Greene in Bull. Calif. Acad. Sci. 1: 114. 1885; Gray, Syn. Fl. N. Am. ed. 2, 2^1: Suppl. 449. 1886.

A nearly glabrous annual; stem terete, freely branched from the base, erect or ascending, 9–30 cm. high, branches mostly reddish-purple; leaves very few, scattered, long-petioled, narrowly spatulate to oblanceolate, 1–3 cm. long, 1–5 mm. broad, denticulate, the upper sessile and mostly linear; pedicels erect in flower, little longer than the corolla, becoming elongated in fruit, spreading or divaricate, rarely recurved; calyx ovate, campanulate, somewhat elliptical in fruit, 9–12 mm. long, almost glabrous, even at the sinuses, teeth nearly equal, obtuse, the lower folding over the lateral ones and nearly closing the orifice; corolla 1.5–2 cm. long, tube exserted, throat densely bearded and dotted with red below the lower lip; style puberulent, stigma-lips

unequal; capsule short-stipitate, compressed, elliptical, little shorter than the calyx; seeds oblong.

Distribution: known only from Lake Co., California, where it grows in open gravelly places.

Specimens examined:

California: Kelsey Mt., Lake Co., June, 1884, *Curran* (G, *type collection*); Lake Co., May, 1890, *K. Brandegee* (G and U. S.); Bradford, Lake Co., May, 1890, *K. Brandegee* (Calif. and Pomona); valley of a tributary of Cache Creek, near Hough's Springs, 10 May, 1919, *Heller 13142* (Cornell and M).

17. **M. nasutus** Greene in Bull. Calif. Acad. Sci. **1**: 112. 1885; Manual Bay Region, 277. 1894; Gray, Syn. Fl. N. Am. ed. 2, 2^1: Suppl. 449. 1886; Howell, Fl. Northwest Am. 521. 1901; Eastwood, Fl. South Fork King's River, Sierra Club Publ. **27**: 65. 1902; Abrams, Fl. Los Angeles, 366. 1904, and ed. 2, 337. 1917; Henry, Fl. Brit. Columbia, 269. 1915; Piper & Beattie, Fl. Northwest Coast, 324. 1915; Rydb. Fl. Rocky Mountains, 778. 1917. Pl. 10, fig. 1.

M. luteus, in part, of many authors.

M. Langsdorfii, in part, of many authors.

M. luteus var. *depauperatus* Gray in Bot. Calif. **1**: 567. 1876, in part; Syn. Fl. N. Am. 2^1: 277. 1878, and ed. 2, 1886.

M. subreniformis Greene in Erythea **3**: 67. 1895.

M. glareosus Greene, Pittonia **2**: 282. 1889; Manual Bay Region, 277. 1894.

M. Langsdorfii var. *nasutus* Jepson, Fl. W. Mid. Calif. 407. 1901, and ed. 2, 379. 1911.

M. erosus Greene, Leafl. Bot. Obs. & Crit. **2**: 4. 1909.

M. minusculus Greene, Leafl. Bot. Obs. & Crit. **2**: 5. 1909.

M. cordatus Greene, Leafl. Bot. Obs. & Crit. **2**: 5. 1909. Woot. & Standl. Contr. U. S. Nat. Herb. **19**: 587. 1915.

M. cuspidatus Greene, Leafl. Bot. Obs. & Crit. **2**: 6. 1909.

M. puberulus Gdgr. in Bull. Soc. Bot. Fr. **19**: 219. 1919, not Greene.

M. Bakeri Gdgr. in Bull. Soc. Bot. Fr. **19**: 219. 1919.

M. Parishii Gdgr. in Bull. Soc. Bot. Fr. **19**: 219. 1919, not Greene.

Puberulent to nearly glabrous annuals, rarely pubescent; stem usually branched from the base, erect or ascending, .5–6 dm. high, quadrangular, frequently winged, fistulous when growing under very favorable conditions; leaves 3–5-nerved, round-ovate or oblong, .5–11 cm. long, nearly as broad, irregularly and coarsely dentate or lobed, often with additional small lobes at the base of the blade, more or less tinged with red on the lower surface, lower leaves with long, broad, clasping petioles, the upper leaves sessile; inflorescence racemose, pedicels nearly glabrous, 2–3 times as long as the mature calyx, erect, becoming strongly recurved in fruit; calyx appressed-puberulent, with short white hairs at the sinuses, frequently tinged with red, much inflated when mature, .6–1.8 cm. long, 3–11 mm. wide, teeth acute, the upper about 3 times as long as the others, the latter folding over and appearing as though truncate with a long index-finger pointing outward; corolla varying greatly in size from .7 to 2.3 cm. long, the lower lip densely bearded, spreading and much longer than the upper lip, usually with a reddish-brown blotch below the middle lobe and numerous smaller dots down the throat; style puberulent, stigma-lips unequal; capsule short-stipitate, oblong; seeds reticulate.

Distribution: in moist places from the Rocky Mountain states and British Columbia, south to northern Mexico; especially abundant in the foothills of California.

Specimens examined:

Idaho: brook edges, Big Willow, Canyon Co., 3000 ft. alt., 1 June, 1910, *Macbride 170* (M and R. Mt.); near Lewiston, Nez Perces Co., 1500–2000 ft. alt., 29 May, 1896, *Heller & Heller 3143* (Cornell and M); wet bank, Salmon, 23 June, 1920, *Payson & Payson 1754* (M).

New Mexico: Van Patten's, Organ Mts., Dona Ana Co., 14 May, 1899, *Wooton 28*, in part (U. S. and Greene).

Arizona: Fort Lowell, 2400 ft. alt., 25 April, 1903, *Thornber 379* (M); banks of the Rillita, 9 April, 1881, *Pringle* (M).

Nevada: Verdi, May, 1890, *Sonne* (M).

British Columbia: Cadboro Bay, Victoria, 1 May, 1908, *Macoun 87662* (Cornell); rocky cliffs, Victoria, 4 April, 1914, *Henry* (R. Mt.).

Washington: rocky springs, Columbia River, W. Klickitat Co., May, 1885, *Suksdorf 792* (M); sandy banks of the Columbia River, W. Klickitat Co., 4 May, 1885, *Suksdorf 476* (G); on bare wet rocks, Mt. Paddo, 5000–6000 ft. alt., 28 June, 1885, *Suksdorf 480* (G); river bank, Bingen, W. Klickitat Co., 17 April, 1905, *Suksdorf 5016* (M); in rock crevices, Almata, 2 May, 1897, *Piper 2783* (G and Pomona); dense patches in springy places on cliffs, Wawawai, Whitman Co., May, 1897, *Elmer 777* (M, R. Mt., and Pomona); Rock Lake, Whitman Co., 1800 ft. alt., 30 May, 1893, *Sandberg & Leiberg 110* (M).

Oregon: wet rocks, eastern Oregon, 15 June, 1897, *Cusick 1627* (Cornell and M); Gibbon, Umatilla Co., 4 June, 1910, *Heller 10192* (Stanford).

California: Marysville Buttes, Sutter Co., 8 April, 1914, *Heller* (M); South Butte, Sutter Co., 20 April, 1891, *Jepson 19m* (Calif.); Berry Canyon, near Clear Creek, Butte Co., 8 May, 1902, *Heller & Brown 5503* (G, Cornell, and M); near Redding, Shasta Co., 26 May, 1905, *Heller 7858* (U. S. and M); near Vina, Tehama Co., 29 April, 1914, *Heller 11339* (M); Alta, Placer Co., June, 1889, *T. S. Brandegee* (M); in cleft of rock, Damp Trail around Echo Lake, Eldorado Co., 13 June, 1920, *Ottley 1180* (Wellesley, Cornell, and M); Little Chico Creek, 1883, *Austin* (G); Webber Lake, 5 May, 1901, *Kennedy & Doten 106* (R. Mt.); Lakeport, April, 1889, *K. Brandegee* (M); Hood's Peak, Sonoma Co., June, 1893, *Michener & Bioletti* (Pomona); wash of the Napa River, between Napa and Yountville, 6 May, 1921, *Ottley 1315* (Wellesley); Yountville, Napa Co., 6 May, 1921, *Jepson 9168* and *9169* (Calif.); Knight's Valley, Sonoma Co., 1877, *Edwards* (G, *type collection*); Calistoga, 6 May, 1921, *Jepson 9172* and *9173* (Calif.); fields east of Santa Rosa, Sonoma Co., 16 April, 1902, *Heller & Brown 5306* (M); creek bed west of Calistoga, 1 May, 1893, *Jepson 6m* (Calif.); Weldon Cañon, Vaca Mts., 17 May, 1892, *Jepson 66m* (Calif.); Lake Co., 30 Aug., 1888, *Greene* (Greene); Mt. St. Helena, Napa Co., 20 April, 1903, *C. F. Baker 2608* (M, R. Mt., and Pomona); Napa Range, east of Calistoga, New Pope Valley Grade, 2 May, 1893, *Jepson 7m* (Calif.); Pope Valley Grade from Calistoga, 1 June, 1909, *K. Brandegee*

(M); Tocaloma, Marin Co., May, 1893, *Michener & Bioletti* (M); trail near Fairfax, Marin Co., 21 April, 1921, *Ottley 1242* (Wellesley and Cornell); Ross Valley, Marin Co., 5 April, 1892, *Jepson 3m* (Calif.); San Rafael Creek, Marin Co., April, 1885, *Gray* (G); above the Alma Soda Spring near the "French Settlement," Santa Clara Co., 14 June, 1904, *Heller 7508* (G, M, and R. Mt.); Smith Creek, at foot of Mt. Hamilton, Santa Clara Co., 30 May, 1907, *Heller 8591* (M); Mt. Stanford, Nevada Co., July, 1890, *Sonne 263* (M); Fisher Cabin, Amador or Calaveras Co., 1200 ft. alt., 13 May, 1896, *Hansen 473* (U. S.); Middle Fork, Amador Co., 1500 ft. alt., April, 1892, *Hansen 1288* (M); New York Falls, Amador Co., April, 1895, *Hansen 1049* (M); Middle Fork, Amador Co., 1500 ft. alt., April, 1893, *Hansen 135* (M and Stanford); in serpentine rock crevices, Red Hills above Peoria Flat, Tuolumne Co., 1600 ft. alt., 11–16 April, 1919, *Ferris 1602* (Stanford); rock crevice, Spring Gulch above Bear Creek, Tuolumne Co., 1050 ft. alt., 11–16 April, 1919, *Ferris 1626* (Stanford); Phoenix Lake near Sonora, Tuolumne Co., 2000 ft. alt., 20 May, 1917, *A. L. Grant 949* (Cornell, Phil., M, U. S., and Calif.); along edges of small streams, Hetch-Hetchy Valley, Tuolumne Co., 3660 ft. alt., 15 June, 1918, *A. L. Grant 1265* and *1266* (Cornell, M, Calif., and Pomona); Hog Ranch, above Hetch-Hetchy Valley, 4700 ft. alt., 16 June, 1917, *A. L. Grant 989* (Cornell and M); Yosemite Falls, 5300 ft. alt., 25 June, 1911, *Jepson 4274a* (Calif.); Yosemite, July, 1902, *Bacon* (Stanford); edge of stream, above Pollasky, Madera Co., 12 April, 1906, *Heller 8158* (M); along edges of small streams, Huntington Lake, Fresno Co., 7000 ft. alt., 25 June, 1917, *A. L. Grant 1006* (Cornell, M, Ore., and Calif.); Huntington Lake, Fresno Co., 20 July, 1917, *A. L. Grant 1133* (U. S., Phil., and Pomona); near Mineral King, 4 Aug., 1891, *Coville & Funston 1457* (Cornell); Santa Barbara, May, 1902, *Elmer 3821* (M); along creeks in cañons, Sierra Santa Monica, June, 1891, *Hasse* (M); Little Santa Anita Cañon, Los Angeles Co., 1 July, 1902, *Abrams 2612* (M); abundant in a mossy seep, small gulch above Canyon Station, San Antonio Mts., 3000 ft. alt., 17 May, 1920, *I. M. Johnston 2307* (M and Pomona); San Jacinto River Canyon,

30 May, 1917, *Jenkins & Street* (Pomona); around small spring, vicinity of Bonanza King Mine, east slope of Providence Mts., Mohave Desert, 21–24 May, 1920, *Munz, Johnston & Harwood 4031* in part (M and Pomona); Milliards Cañon, San Gabriel Mts., 2500 ft. alt., 19 May, 1918, *Pierson 197* (Calif.); Reche Cañon, near San Bernardino, 20 May, 1894, *Parish* (Calif.); southern slope of the San Bernardino Mts., 3500 ft. alt., 29 May, 1906, *Parish 5764* (R. Mt.); wet sand in wash, Upland, San Bernardino Co., 4 May, 1917, *Parish 11170* (M); Cascade Cañon, San Antonio Mts., 4250 ft. alt., 23 June, 1918, *I. M. Johnston* (Pomona); edge of small stream, Devil's Canyon, 1500 ft. alt., 10 May, 1919, *Munz 2780* (Pomona); Harvey's Ranch, near El Nido, San Diego Co., 20 May, 1903, *Abrams 3538* (M); stream-sides and canyons, La Jolla, 1 June, 1914, *Clements & Clements 126* (M).

Mexico:

Chihuahua: springy places, Sierra Madre, 29 Sept., 1887, *Pringle 1347* (U. S.).

Lower California: near San Rafael, northern Lower California, 11 July, 1885, *Orcutt 1304* (M); All Saints Bay, April, 1885, *Greene* (G); Santa Agneda, 1890, *Edw. Palmer 233* (U. S.); Lower California, 4–6 March, 1890, *Edw. Palmer 233* (U. S.).

This species exhibits wide variation in the size of the plant, the length of the flowers, and of the leaves. This is due, apparently, to a response to environmental conditions, moisture being the main factor concerned. The following specimens are noteworthy in showing strongly geniculate stems and mostly thinner leaves: *Heller & Brown 5503*, *Ferris 1602* and *1626*, and *Heller 7508*. They merge into the typical condition, sometimes in the same collection, so that it does not seem desirable to consider them as varieties. *Suksdorf 480* from Washington and *Wooton 28* from New Mexico are glabrous plants, having nearly orbicular leaves and an almost entire margin.

17a. Var. insignis (Greene) Grant, comb. nov.

M. guttatus var. *insignis* Greene, Manual Bay Region, 277. 1894.

M. Langsdorfii var. *insignis* Greene in Jour. Bot. 33: 7. 1895; Jepson, Fl. W. Mid. Calif. 407. 1901, and ed. 2, 379. 1911.

Stems erect, internodes elongated; leaves few, rounded, ovate, coarsely dentate, sometimes with small lobes at the base; calyx tinged and spotted with red, upper tooth usually shorter than in the species; corolla 2.5–4.5 cm. long, throat abruptly expanded and very wide.

Distribution: central valley region in California.

Specimens examined:

California: wet meadow between Mud Flat and Bennett Spring, Glenn Co., 27 April, 1916, *Heller 12344* (Cornell and M); Adobe Cañon, Sonoma Co., April, 1893, *Bioletti* (M and R. Mt.); Adobe Cañon, April, 1893, *Michener & Bioletti* (M); near Sonoma, Sonoma Co., 23 April, 1902, *Heller & Brown 5349* (Cornell, M, and Pomona); low meadows, La Lomita, Napa River Basin, 26 April, 1893, *Jepson 8m* (Calif., "the exact type" according to Jepson, and R. Mt.); near Sonoma, 18 April, 1862, *Brewer 974* (G and U. S.).

A strikingly beautiful plant, merging into the species through such specimens as *C. F. Baker 2608* from Mt. St. Helena.

17b. Var. **micranthus** (Heller) Grant, comb. nov.

M. micranthus Heller in Muhlenbergia 8: 132. 1912.

Stems glabrous, weak, 3–6 dm. long; lower leaves long-petioled, lyrate, 6–8 cm. long, upper leaves thin, sessile, broadly orbicular, floral leaves densely white-villous on the lower surface; flowers in a short raceme, pedicels usually more than twice as long as the calyx, slender; calyx puberulent, more or less tinged and spotted with red, 8–11 mm. long in fruit, upper tooth not always 3 times as long as the others, throat sometimes slightly constricted; corolla 8–13 mm. long, less than twice the length of the calyx.

Distribution: wet places in Nevada and central California. Rarely collected.

Specimens examined:

Nevada: by a spring, Jarbridge, 6 July, 1912, *Nelson & Macbride 1959* (M and R. Mt.).

California: Metcalf's Ranch, northeast base of Mt. Eddy, 3800 ft. alt., 20 June, 1919, *Heller 13256* (M and Cornell); Alton, Humboldt Co., 9 June, 1912, *Tracy 3688* (M and R. Mt.); Yountville, Napa River Basin, 26 April, 1893, *Jepson 12m*

(Calif.); Twenty-seven Mile Drive near Congress Springs, Santa Clara Co., 13 May, 1904, *Heller 7410* (M and R. Mt., *type collection*); foothills west of Los Gatos, Santa Clara Co., 700 ft. alt., 30 April, 1908, *Heller 8936* (M and Stanford); foothills near Stanford University, 2 May, 1902, *C. F. Baker 881* (Pomona).

18. **M. laciniatus** Gray in Proc. Am. Acad. **11**: 98. 1876; Bot. Calif. **1**: 567. 1876; Syn. Fl. N. Am. 2^1: 277. 1878, ed. 2, and Suppl. 449. 1886; Greene in Bull. Calif. Acad. Sci. **1**: 114. 1885; Hall, Yosemite Fl. 221. 1912.

M. Eisenii Kell. in Proc. Calif. Acad. Sci. **7**: 89. 1877.

A nearly glabrous annual; stem erect or ascending, freely branched from the base, 3–35 cm. high, terete or somewhat quadrangular, often tinged with red; leaves few, 1–5 cm. long, mostly long-petioled, 1-nerved, variously cut, lobed or pinnately-parted, the apex obtuse, basal leaves generally numerous and in a rosette; pedicels slender, longer than the leaves, glandular-puberulent at the base, erect in flower, becoming recurved when mature, the fruiting calyx often standing at right angles to the pedicels and about half their length; calyx oblong, .5–1.5 cm. long, more or less spotted with reddish-purple, the angles tinged with the same color, villous with shaggy white hairs below the sinuses, teeth triangular-acute, the upper one little over twice the length of the others; corolla .7–1.8 cm. long, usually with a single large reddish-brown spot on the middle lobe of the lower lip, sometimes with smaller dots below; stigma-lips unequal, style puberulent; capsule short-stipitate, oblong.

Distribution: in more or less open moist patches in granite sand or in rocky places. Collected only in the Sierra Nevada Mountains from Tuolumne Co. to Fresno Co., California.

Specimens examined:

California: in damp rocky places, Strawberry Lake, Tuolumne Co., 10 June, 1917, *A. L. Grant 951* (G, U. S., Cornell, Ore., Stanford, and Pomona); in damp granite sand, Hog Ranch, above Hetch-Hetchy Valley, Tuolumne Co., 4700 ft. alt., 16 June, 1917, *A. L. Grant 997* (N. Y., Phil., Cornell, M, R. Mt., Calif. Acad., and Calif.); in damp granite sand, Hog Ranch,

Tuolumne Co., 4700 ft. alt., 14 June, 1917, *A. L. Grant 983* (G, Cornell, M, Ore., and Calif.); on a branch of the Merced at Clark's (now Wawona), 1872, *Sullivan & Gray* (G, TYPE); Merced River, 4 miles below Yosemite, Aug., 1883, *Meehan* (G and M); Yosemite Falls, 5300 ft. alt., 25 June, 1911, *Jepson 4274* (Calif.); Cloud's Rest, Yosemite, 1883, *Curran* (G); foot of Yosemite Falls, 22 June, 1911, *Abrams 4485* (Stanford); Pine Ridge, Fresno Co., 5300 ft. alt., 15–25 June, 1900, *Hall & Chandler 123* (M and Stanford); river bed of the Marble Fork, Sequoia Park, about 5500 ft. alt., 24 June, 1900, *Jepson 658* (Calif.); no data, *Eisen* (Calif. Acad.).

The irregularly lobed leaves of *M. laciniatus* readily separate it from the other species in this section. Depauperate forms sometimes show little lobing of the leaves and may cause such plants to be confused with *M. nasutus*.

19. **M. Whipplei** Grant[1]

A small more or less glandular-villous annual, much branched from the base; branches numerous, simple, 10–15 cm. high; leaves broadly ovate, acute, coarsely dentate, 3–5-nerved from the base, lower leaves petioled, 1.5–3 cm. long, .6–1.5 cm. wide; pedicels slender, at least twice as long as the leaves; calyx campanulate, 6–7 mm. long, slightly inflated in fruit, teeth broadly triangular-acute, unequal, the upper scarcely twice the length of the others, villous at the sinuses, often spotted with red; corolla campanulate, 1.8–2.2 cm. long, yellow, tube exserted, throat short, expanding abruptly at the wide limb, 1.5–2 cm. broad, lobes unequal, broad, rounded, the lower lip exceeding the upper; stamens included, filaments minutely puberulent, anthers glabrous, anther-cells coherent nearly half their length; style glabrous; stigma-lips unequal; capsule about one-half as long as the calyx-tube, subglobose, compressed, stipitate by a broad base; seeds oblong, papillate.

[1] **Mimulus Whipplei** Grant, sp. nov., annuus, ad basim multo-ramosus; ramis simplicibus, 10–15 cm. altis; foliis late ovatis, acutis, grosse dentatis; calyce 6–7 mm. longo, dente supremo alteris valde duplo longiore; corolla 1.8–2.2 cm. longa, flava, limbo, 1.5–2 cm. lato; capsula subglobosa, stipitata.—Collected on hillsides and rocky places, Murphy's, Calaveras Co., 14 May, 1854, *Bigelow* (Gray Herb., TYPE, and U. S. Nat. Herb.).

Distribution: known only from the type locality.

Specimens examined:

California: hillsides and rocky places, Murphy's, Calaveras Co., 14 May, 1854, *Bigelow* (G, TYPE, and U. S.).

20. M. pallens Greene, Leafl. Bot. Obs. & Crit. **2**: 4. 1909.

A small glabrous annual; stem 2–8 cm. long, slender, freely branched, internodes elongated; leaves pale-green, few, broadly obovate, spatulate or suborbicular, 4–14 mm. long, thin, nearly entire or sparingly and irregularly dentate, the lower with winged petioles, upper sessile; flowers in a short loose raceme or terminal, pedicels mostly three or more times the length of the corolla, almost filiform; mature calyx usually 3-toothed, oval, 4–8 mm. long, teeth broadly triangular, obtuse, the two lower occasionally cleft at the apex, and folded toward the very large upper one, nearly closing the orifice, sinuses broad; corolla funnelform, .8–1.5 cm. long, tube slender, exserted, lobes rounded, unequal; style glabrous, scarcely longer than the mature calyx, stigma-lips nearly elliptical, unequal; capsule oblong, acute, about one-third the length of the calyx, short-stipitate; seeds oblong, longitudinally wrinkled.

Distribution: wet places in northern Mexico.

Specimens examined:

Chihuahua: springy places, Sierra Madre, 29 Sept., 1887, *Pringle 1347* (Phil.); near Colonia Garcia in the Sierra Madre, 7400 ft. alt., 12 Sept., 1899, *Townsend & Barber 324* (M and Phil.).

Durango: Santiago Papasquiaro, April and August, 1896, *Edw. Palmer 55* (U. S., TYPE, and M); San Ramon, 21 April–18 May, 1906, *Edw. Palmer 87* (M and Phil.).

21. M. dentilobus Rob. & Fern. in Proc. Am. Acad. **30**: 120. 1895; Conzatti & Smith, Fl. Sin. Mex. 117. 1897.

M. parvulus Woot. & Standl. Contr. U. S. Nat. Herb. **16**: 171. 1913; **19**: 587. 1915.

Low creeping plants, rooting from the nodes and forming dense mats; stems 3–5 cm. high, slender, terete, nearly glabrous or sparsely pubescent; leaves broadly ovate or suborbicular, 2–7 mm. long, 2–5 mm. wide, dentate, crenate or nearly entire, mostly

with winged petioles, shorter than the blade, more or less covered with stiff white hairs; flowers few, axillary or terminal, pedicels pubescent, slender, almost filiform, much exceeding the leaves; mature calyx turbinate, 5–7 mm. long, sparsely pubescent, rarely glabrous, teeth triangular-acute, the lower and upper teeth longer than the lateral ones, folding over and nearly closing the orifice; corolla 9–13 mm. long, throat spotted with red below the lower lip, lobes erose or somewhat laciniate; style puberulent or glabrous; capsule oblong, less than half the length of the calyx, compressed, not stipitate; seeds brownish, oval, sometimes 3-sided, longitudinally striate and often bearing stiff scattered hairs.

Distribution: in wet places in southwestern New Mexico, and in northern Sonora and Lower California. Rarely collected.

Specimens examined:

New Mexico: Rocky Canyon, Grant Co., 29 Aug., 1911, *Holzinger* (M); Rocky Canyon, 9 Aug., 1911, *Holzinger* (U. S.).

Mexico:

Sonora: Nacori, 3750 ft. alt., 4 Dec., 1890, *Hartman 288* (G, TYPE); Bavispe River, 23 Dec., 1890, *Lloyd 440* (G and Calif.).

Lower California: Puerto Escondido in Sierra Giganta, back of Bay, about 1700 ft. alt., 14 June, 1921, *I. M. Johnston 4113* (Calif. Acad.).

A curious *Mimulus*, unlike the other species because of its hairy leaves, the shape of the mature calyx, the erose or laciniately lobed corolla, and the seeds.

22. **M. crinitus** Grant, nom. nov.

M. acutidens Reiche, Fl. Chile 6[1]: 63. 1911, not Greene.

Plants hairy; stems weak, diffuse; leaves ovate, acute, 6–7 cm. long, thin, short-petioled; pedicels shorter than the leaves; calyx cylindrical, 1–1.5 cm. long, teeth linear, subulate, the upper tooth larger; corolla 2–2.4 cm. long, yellow; capsule unknown.

Distribution: swamps in the Province of Valdivia, Chile.

Specimens of this species have not been seen by the writer, and the above diagnosis is compiled from the original description.

23. **M. depressus** Phil. Fl. Atac. 45. 1860; Reiche, Fl. Chile 6[1]: 62. 1911.

A low glabrous perennial; stems short; leaves in a basal rosette, crowded, ovate, short-petioled, 3–4 cm. long, 2–2.5 cm. broad, serrate-dentate, short-petioled, blade with a transverse dark bar; flowers subsessile, crowded at the apex of the stem; calyx 4–5 mm. long; corolla 1.4–1.5 cm. long, not spotted.

Distribution: in swamps in the high mountains in Atacama and Coquimbo, Chile.

23a. Var. **nanus** (Phil.) Reiche, Fl. Chile **6**[1]: 62. 1911.

M. nanus Phil. Fl. Atac. 45. 1860, not Hook. & Arn.

Plants small; stems scarcely 2.5 cm. high, mostly 1-flowered; leaves ovate, 5 mm. long, entire, short-petioled; corolla 6 mm. long.

Distribution: in wet places in the Sandon Valley in the desert of Atacama, Chile.

These plants are known to the writer only from the descriptions cited above. The variety was originally described from five plants collected by a spring in the Sandon Valley, Chile. It may be a depauperate form of the species or examination of authentic material may show it to be specifically distinct.

24. **M. pilosiusculus** HBK. Nov. Gen. & Sp. **2**: 370. 1817; Benth. in DC. Prodr. **10**: 371. 1846; McCloskie in Princeton Patagonia Exp. **8**[2]: 721. 1903–1906.

M. sylvaticus Phil. in Linnaea **30**: 197. 1859–60; Reiche, Fl. Chile **6**[1]: 62. 1911.

A low pubescent perennial with stems .5–1.5 cm. long, procumbent or creeping, freely branched; leaves numerous, mostly crowded, the lower short-petiolate, broadly ovate or oblong-ovate, 1.6–1.8 cm. long, 6–12 mm. wide, acute or obtuse, irregularly dentate, pale green, the upper sessile or short-petioled; flowers axillary, numerous, pedicels slender, mostly shorter than the leaves; calyx 5–6 mm. long, inflated and oval when mature, 6–8 mm. long, the throat slightly constricted, teeth spreading, broadly triangular-acute, the upper longer and much broader; corolla 1–1.4 cm. long; capsule oblong, almost as long as the calyx-tube, not stipitate; seeds smooth, oval, nearly as broad as long.

Distribution: Peru, Chile, and Argentine Republic.

Specimens examined:
Chile: Quillota, without date or collector (G).
Argentine Republic: General Roca and vicinity, Rio Negro Valley, 750–1100 ft. alt., 19 Jan., 1915, *Fischer 266* (U. S., Cornell, and M).

This plant is closely related to *M. glabratus* and may be only a pubescent, short-pedicelled form of that species.

25. **M. glabratus** HBK. Nov. Gen. & Sp. **2**: 370. 1817; Benth. Scroph. Ind. 28. 1835; DC. Prodr. **10**: 371. 1846; Gray in Bot. Mex. Bound. 116. 1859; Syn. Fl. N. Am. ed. 2, 2^1: Suppl. 447. 1886; Conzatti & Smith, Fl. Sin. Mex. 117. 1897.

M. andicolus HBK. Nov. Gen. & Sp. **2**: 370. 1817.

M. Jamesii var. *texensis* Gray, Syn. Fl. N. Am. 2^1: 277. 1878, and ed. 2, 1886; Greene in Bull. Calif. Acad. Sci. **1**: 118. 1885.

M. tener Phil. in Anal. Mus. Nac. Chile **1**: 70. 1891; Reiche, Fl. Chile 6^1: 64. 1911.

A low perennial, glabrous or nearly so, aquatic or semi-aquatic, stoloniferous or with creeping stems which root freely at the lower nodes; stems usually numerous, hollow, weak, 1–4 cm. long; leaves broadly ovate, 1.5–5 cm. long, .8–3 cm. broad, irregularly dentate, sometimes shallowly lobed at the base, 3–5-nerved, basal leaves cuneate, subcordate or with margined petioles, these usually shorter than the blade, upper leaves subcordate, sessile; flowers axillary, chiefly along the upper parts of the stem, pedicels slender, nearly filiform in some specimens, longer or shorter than the leaves; calyx campanulate, often spotted or tinged with red, 5–8 mm. long, broadly oval in fruit, 1–1.2 cm. long, teeth broad, spreading, very short, the upper tooth 2 or more times longer than the others, all broadly rounded, sometimes mucronate, the apex appearing acute only when folded, throat little, if at all, constricted; corolla tubular, .7–1.5 cm. long, tube slender, lower lip heavily bearded, middle lobe much longer than the lateral ones; style glabrous; capsule oblong, rounded, constricted at the base, not stipitate, shorter than the calyx-tube; seeds oval, longitudinally striate.

Distribution: in shallow water or muddy places; the stems floating or creeping and more or less procumbent. Oklahoma to Bolivia.

Specimens examined:

Oklahoma: in shallow running water, Thackerville, Love Co., 15 April, 1913, *Stevens 63* (M).

Texas: New Braunfels, Aug., 1851, *Lindheimer 717* (M); along the streams, San Saba, April, 1882, *Reverchon 1341* (M and Stanford); rocky pool margins, Spring Creek, San Saba Co., 4 May, 1917, *E. J. Palmer 11793* (M); Austin, April, 1848, *Wright* (G); river bank, Austin, 13 May, 1872, *E. Hall 410* (M); Limpia Cañon, western Texas, 25 April, 1902, *Tracy & Earle 220* (Cornell and M).

New Mexico: copper mines, 1851–52, *Wright 1482* (G and M).

Mexico:

Coahuila: Saltillo, 1898, *Edw. Palmer 124* (M).

Sonora: Sonora, 1890, *Lloyd 438* (G).

Durango: in wet places, Nombre de Dios, near the city of Durango, April, 1896, *Edw. Palmer 104* (G and M); common in water and wet places near the city of Durango, June, 1896, *Edw. Palmer 164* (G and M).

San Luis Potosi: Alvarez, 28 Sept.–3 Oct., 1902, *Edw. Palme 179* (M).

Mexico: Ixtaccihuatl, 10000–11000 ft. alt., March–July, 1903, *Purpus 327* (M and Pomona); about Mexico, *Berlandier 781* (M).

Hidalgo: by brooks, barranca below Trinidad Iron Works, 5500 ft. alt., 22 Aug., 1904, *Pringle 13149* (G, U. S., and Cornell).

Michoacan: on rocks of aqueduct near Chapultepec, 16 April, 1849, *J. Gregg* (M).

Puebla: Route de Chohila, vicinity of Puebla, about 7300 ft. alt., 14 March, 1907, *Bro. Arsène* (M).

Oaxaca: Sierra de San Felipe, 10000 ft. alt., Sept., 1894, *C. L. Smith 406a* (M).

Chiapas: Chiapas, 1864–70, *Ghiesbreght 682* (M).

Central America:

Guatemala: Dueñas, Dept. Zacatepequez, 5000 ft. alt., April, 1890, *J. D. Smith 2127* (G and U. S.).

South America:

Colombia: ditch in field, Rio San Cristobal, near Bogotá, 20–26 Sept., 1917, *Pennell 2194* (M); in ditch, San Cristobal, Bogotá,

about 8500 ft. alt., 30 Sept., 1917, *Pennell 2279* (M); springhead in meadow, Zipaquira, Cundinamarca, 20–24 Oct., 1917, *Pennell 2533* (M).

Ecuador: Quitensian Andes, 1855, *Couthouy* (G); in the Andes Mts., 1857–59, *Spruce 5168* (G).

Bolivia: vicinity of Cochabamba, 1891, *Britton & Rusby 1014* (M); Bermejo, 16 Nov., 1903, *Fiebrig 2077* (G).

Argentine Republic: common in creeks, Andalgalia, 11 Sept., 1915, *Jörgensen 980* (M); Cordillera del Chubut, Corcobado River, Feb., 1903, *Illin 165* (Calif.); La Cienaga, Sierra de Tucaman, 17 Nov., 1874, *Hieronymus & Lorentz 719* (U. S.).

While *M. glabratus* is closely allied to *M. guttatus*, it can readily be distinguished from that species by the shape of the mature calyx. This is broadly campanulate and the teeth do not fold over, closing the orifice. All of the teeth, except the upper one, are very short, sometimes hardly more than mucronate, giving a characteristic short stubby appearance to the fruiting parts. Variations occur, however, and in some specimens we find good-sized blunt teeth, all shorter than the upper one. Ordinarily, the plants are glabrous, but numerous specimens show a well-developed pubescence at the nodes, on the upper part of the stem and on the pedicels. This species and its varieties form the most widely distributed group in the genus, occurring from southern Canada, through Mexico and Central America to Rio Negro in Argentine Republic.

25a. Var. **Fremontii** (Benth.) Grant, comb. nov.

M. Jamesii var. *Fremontii* Benth. in DC. Prodr. **10**: 371. 1846.

M. Geyeri Torr. in Nicoll. Rept. Miss. 157. 1843; Nelson in Coulter & Nelson, Manual Cent. Rocky Mountains, 454. 1909; Woot. & Standl. Contr. U. S. Nat. Herb. **19**: 587. 1915; Rydb. Fl. Rocky Mountains, 779. 1917; Britton & Brown, Ill. Fl. ed. 2, **3**: 191, *fig. 3778*. 1913.

M. Jamesii Torr. & Gray in Benth. DC. Prodr. **10**: 371. 1846; Gray, Syn. Fl. N. Am. **2**[1]: 276. 1878, and ed. 2, 1886; Greene in Bull. Calif. Acad. Sci. **1**: 118. 1885; Britton & Brown, Ill. Fl. **3**: 158, *fig. 3268*. 1896; Britton, Manual, 828. 1901, and ed. 2, 1905; Conzatti & Smith, Fl. Sin. Mex. 117. 1897. Small, Fl. Southeastern U. S. 1063. 1903.

M. reniformis Engelm. ex Benth. in DC. Prodr. **10**: 371. 1846.

M. madrensis Seem. in Bot. Herald, 322, *pl. 58.* 1852–57.

M. glabratus var. *Jamesii* Gray, Syn. Fl. N. Am. ed. 2, 2[1]: Suppl. 447. 1886; Robinson & Fernald in Gray, Manual, ed. 7, 723. 1908.

M. inamoenus Greene, Pittonia 5: 137. 1903.

Leaves mostly suborbicular, oval with a rounded apex and subcordate base or occasionally nearly reniform, margin entire, undulate, denticulate or irregularly and sparsely dentate; pedicels and calyx often pubescent.

Distribution: common in shallow water or in muddy places, through central North America from Manitoba to Mexico, west to Montana, Nevada and Arizona; apparently a calcophile.

Specimens examined:

Manitoba: river bank, growing in running water, Aweme, 5 Aug., 1905, *Criddle* (M).

Michigan: in water at outlet of spring, Black Lake, Cheboygan, 20 Aug., 1890, *Kofoid* (M); aquatic herb in Carp Creek, near Douglas Lake, Cheboygan Co., 21 July, 1917, *Gates & Gates 10618* (M).

Wisconsin: Delavan Lake, Walworth Co., 14 June, 1896, *Skeels* (Cornell); St. Croix Falls, Polk Co., 7 Aug., 1900, *C. F. Baker* (Pomona).

Illinois: Peoria, 1859, *Brendel* (M).

Minnesota: Minnehaha Falls, 12 Aug., 1886, *Wislizenus 561* (M); Minneapolis, 17 Aug., 1873, *Herrick 33* (M); Cannon Falls, July, 1891, *Sandberg 376* (Stanford).

Iowa: limestone springs, Clinton Co., 1 July, 1878, *Butler 24* (M); in clear running water near the Missouri River, 27 May, 1920, *James* (N. Y.).

Missouri: Springfield, 5 May, 1888, *Blankinship* (M); in springs, Barry Co., 15 Aug., 1895, *Blankinship* (R. Mt.); wet limestone ledges about spring, bluffs of Mississippi River near Ste. Genevieve, 25 June, 1920, *E. J. Palmer 18035* (M).

North Dakota: in mud and water, Kathryn, 18 July, 1912, *Bergman 2290* (M); in springs at end of Lake, Stump Lake Springs, 25 July, 1911, *Tufte 227* (R. Mt.); Devil's Lake, Nicollet's Northwestern Exp., 1 Aug., 1839, *Geyer 119* (N. Y. and M).

South Dakota: banks of stream in Rapid Creek Canyon, Rapid City, 19 Aug., 1891, *T. A. Williams* (M); Big Stone Lake, Aug., 1892, *T. A. Williams* (M).

Nebraska: wet places, Jim Creek, Hot Creek Basin, 4500 ft. alt., 24 June, 1890, *T. A. Williams* (M); in streams and brooks, Halsey, 10 June, 1903, *Mell & Knopf* (M); Thedford, 7 Aug., 1889, *Webber* (M); Franklin, 2000 ft. alt., 17 May, 1893, *Laybourn 16* (M); Chelsea, Holt Co., 4 Aug., 1893, *Clements 2969* (Cornell).

Kansas: bogs, Riley Co., 21 May, 1895, *Norton 379* (M and R. Mt.); Arlington, 31 July, 1899, *White 81* (M); St. George, 30 May, 1892, *Hitchcock* (M); Manhattan, Riley Co., 10 May, 1894, *Kellerman* (M).

Oklahoma: Garfield Co., 27 June, 1900, *White 149* (M); in shallow pond, near Doby Springs, Harper Co., 5 May, 1913, *Stevens 318* (M); in edge of creek near Knowles, Beaver Co., 5 May, 1913, *Stevens 330* (M); in edge of spring, near Cleo, Major Co., 8 June, 1913, *Stevens 782* (M); in edge of small creek, near Alva, Woods Co., 16 April, 1914, *Stevens 3010* (M); Woods Co., 28 June, 1900, *White 6* (M and R. Mt.).

Texas: seepy loam slope, Austin, 15–16 May, 1920, *Pennell 10444* (M); base of Glouse Mt., May, 1884, *Reverchon* (M); abundant in spring water, Pinto Canyon, near Rindosa, 13 April, 1919, *Hansen 590* (M).

Montana: Missoula, 10 Sept., 1898, *Griffith* (M).

Wyoming: P. F. Ranch, Pratt, Converse Co., 25 Aug., 1901, *H. B. Baker 30* (M); in a spring pool, Platt River, Natrona Co., 27 June, 1901, *Goodding 130* (Cornell, M, R. Mt., Stanford, and Pomona); in margin of stream, Wendover, 22 Aug., 1910, *Nelson 9545* (M and R. Mt.); Whalen Cañon, 19 July, 1894, *Nelson 543* (Cornell, M, and R. Mt.); in a spring bog, Badger, Laramie Co., 1 July, 1901, *Nelson 8344* (Cornell, M, and R. Mt.).

Colorado: Pole Creek to South Platt, Lieut. Bryan's Exp., 1856, *Engelmann* (G and M); Rocky Mt. Flora, 1862, *Hall & Harbour 399* (Cornell and M); New Windsor, Weld Co., 26 Aug., 1902, *Osterhout 2716* (R. Mt. and Pomona); along the Platt River, Denver, 12 June, 1878, *Jones 212* (M); wet springy

places near Riverside, Denver Co., 15 July, 1915, *Munz 137* (Cornell); swamp near Greeley, 28 June, 1907, *E. L. Johnson 120* (M): swampy creek banks, Paradox, Montrose Co., 5400 ft. alt., 19 June, 1912, *Walker 118* (R. Mt.); Cuchara Valley near La Veta, 17 May, 1900, *Rydberg & Vreeland 5659* (R. Mt.); Wray Yuma Co., 23 June, 1915, *Osterhout 5253* (R. Mt.).

Utah: in a swamp near Utah Lake, 18 Sept., 1858, Lieut. Bryan's Exp., *Hayden* (M).

Nevada: Reno, Sept., 1888, *K. Brandegee* G and M); Reno, Sept., 1888, *T. S. Brandegee* (U. S.).

New Mexico: Mangos Springs, near Silver City, Grant Co., 4770 ft. alt., 27 June, 1903, *Metcalfe 208* (G); Bear Mt. near Silver City, Grant Co., near 5000 ft. alt., 24 April, 1903, *Metcalfe 28* (M); in the water of springs and rivulets, Santa Fe, May and June, 1847, *Fendler 559* (M); Cold Spring, 4 Sept., 1895, *Mulford 1152* (M); by spring, 10 miles west of Datil, Datil Nat'l Forest, Socorro Co., 8400 ft. alt., 3 July, 1918, *Ferris 1204* (Stanford); in running water, Bear Spring, Sandia Mts., 6000 ft. alt., Aug.–Sept., 1911, *Ellis 294* (M).

Arizona: Chiricahua Mts., 10 April, 1894, *Price* (Stanford).

Mexico:

Coahuila: water plant, Saltillo, 22 March, 1847, *Gregg 331* (M); in water, Saltillo, 6 March, 1847, *Gregg 195* (M); marshy place at San Juan de la Vacqueria, 20 May, 1847, *Gregg 716* (M).

Chihuahua: vicinity of Chihuahua, 5–10 June, 1908, *Edw. Palmer 366* (M); vicinity of Chihuahua, 1–21 May, 1908, *Edw. Palmer 162* (G and M).

Durango: Tobar, 28–31 May, 1906, *Edw. Palmer 235* (M).

Vera Cruz: Citlaltepetl, 12000–13000 ft. alt., Sept., 1907, *Purpus 2805* (M).

Queretaro: Queretaro, about 5500 ft. alt., 1910, *Bro. Agüiel 10254* (M).

Michoacan: Cerro San Miguel, near Morelia, about 6600 ft. alt., Dec., 1910, *Bro. Arsène 5310* (M); vicinity of Morelia, 2 Feb., 1912, *Bro. Arsène 9936* (G and M).

This variety can usually be distinguished by the suborbicular shape of its leaves with entire or sparsely and irregularly denticulate margins. Many intermediates occur, as *Tracy & Earle 220*

from Texas, *Palmer 104* and *164* from Mexico, *Berlandier 781* from Mexico, and *Stevens 330* from Oklahoma. In some of these specimens, it was difficult to decide whether the plants belonged to the species or to the variety, so closely were they associated. The specimens of Mr. and Mrs. T. S. Brandegee from Reno, Nevada, are worthy of special mention in that the upper parts are decidedly viscid-pubescent. Mrs. Brandegee says that plants with an occasional sterile fifth filament were found among the specimens in this collection.

25b. Var. **parviflorus** (Lindl.) Grant, comb. nov.

M. parviflorus Lindl. Bot. Reg. *pl. 874*. 1825; Trans. Hort. Soc. London **6**: 294. 1826; Benth. Scroph. Ind. 28. 1835; DC. Prodr. **10**: 371. 1846; Clos in C. Gay, Hist. Chile **5**: 141. 1849.

M. propinquus Lindl. Bot. Reg. *pl. 1330*. 1830; Hook. Fl. Bor. Am. **2**: 99. 1840; Benth. in DC. Prodr. **10**: 371. 1846.

M. luteus var. *micranthus* Phil. in Linnaea **29**: 28. 1857–58; Reiche, Fl. Chile **6**^{1}: 60. 1911.

M. Kingii Phil. in Anal. Univ. Chile **43**: 528. 1873; Reiche, Fl. Chile **6**^{1}: 61. 1911.

Creeping or procumbent annuals, freely rooting at the lower nodes, more or less pubescent above; stems terete; leaves broadly ovate, base subcordate or nearly truncate, lower leaves tapering to margined petioles, upper leaves sessile; calyx-teeth short, triangular-acute, upper at least twice as long as the others; corolla tubular, usually less than twice the length of the calyx, throat dotted with red.

Distribution: in wet places in Chile and Argentine Republic. Specimens scarce in American herbaria.

Specimens examined:

South America:

Chile: Province de Chile, without date, *C. Gay* (G); near Santiago, 1899, *Najarre* (Cornell); Valparaiso, without date, *Mertens* (M); Desert of Atacama, Sept.–Oct., 1890, *Morong 1213* (G and Phil.).

Argentine Republic: Andes of Mendoza, without date, *Gillies* (G); Uspallata near Mendoza, 1825, *Gillies* (G).

The original description and plate of *M. parviflorus* correspond

so closely with *M. glabratus* that even with the limited material at hand the writer has no hesitation in regarding it as a mere variation of *M. glabratus*, separated mainly by the extent of the pubescence. Additional material may show the two to be conspecific. Lindley said that *M. parviflorus* differed from *M. glabratus* in not having square stems and in being hairy but this does not hold. The amount of hairiness is variable. Plants grown from seed of Jörgensen's collection no. 980 from Argentine Republic showed much diversity: some of the plants were glabrous, some had distinctly pubescent petioles, pedicels, and calyces, and some were merely puberulent. In this section, annual or perennial characters seem to be largely dependent on the amount of water present and the conditions under which the individual plants are growing, so that these could not be used for specific diagnosis unless accompanied by other more important differences.

Section 4. Paradanthus Grant

§ 4. Paradanthus Grant, new section.

§ *Eumimulus* Gray, Syn. Fl. N. Am. 2. ed. 2, 2[1]: Suppl. 446. 1886, in part.

§ *Simiolus* Greene in Bull. Calif. Acad. Sci. 1: 109. 1885, in part.

Annuals or perennials, glabrous, glandular, viscid-pubescent or slimy-villous; calyx campanulate, occasionally inflated in fruit, rarely with corky ribs, teeth equal or nearly so; corolla mostly funnelform, sometimes bilabiate, throat commonly ampliate, lobes equal or unequal, pink, reddish-purple, yellow, or blue, rarely white; stamens usually included; style glabrous or pubescent, stigma-lips equal or unequal; capsule dehiscent to the base along both sutures, placentae completely united, separated at the apex or occasionally divided to the middle and adherent to the valves. Sp. 26–69.

Key to the Species

A. Mature calyx strongly inflated.
 a. Style shorter than the ovary.
  α. Corolla less than 7 mm. long........................*30. M. breviflorus*
  β. Corolla more than 9 mm. long........................*31. M. latidens*

b. Style longer than the ovary.
 α. Calyx-teeth short, giving a truncate appearance when in fruit.
  I. Pedicels less than twice as long as the leaves.
   1. Anthers glabrous.
    * Leaves sessile .... *36. M. Bodinieri*
    ** Leaves petioled .... *35. M. nepalensis*
   2. Anthers villous.
    * Corolla more than 1.2 cm. long.
     † Pedicels longer than the leaves .... *32. M. acutidens*
     †† Pedicels shorter than the leaves .... *33. M. Grayi*
    ** Corolla less than 1.2 cm. long .... *34. M. inconspicuus*
  II. Pedicels more than twice as long as the leaves .... *39. M. Bridgesii*
 β. Calyx-teeth distinct, not giving a truncate appearance when in fruit.
  I. Leaves mostly ovate, dentate .... *44. M. floribundus*
  II. Leaves mostly elliptical, entire or sparingly denticulate .. *43. M. arenarius*

B. Mature calyx little or not at all inflated, sometimes distended by the mature capsule.
 a. Corolla-lobes distinctly unequal.
  α. Low prostrate perennials.
   I. Stems creeping, rooting freely at the nodes.
    1. Stems succulent.
     * Leaves sessile .... *26. M. repens*
     ** Leaves petioled .... *27. M. orbicularis*
    2. Stems not succulent.
     * Leaves narrowly oblong.
      † Pedicels shorter than the leaves .... *28. M. prostratus*
      †† Pedicels much longer than the leaves .... *29. M. pusillus*
     ** Leaves broadly ovate .... *49. M. pachystylus*
   II. Stems decumbent, producing runners ...... *45. M. jungermannioides*
  β. Stems more or less erect, mostly annuals.
   I. Calyx-throat oblique.
    1. Calyx-teeth subequal.
     * Leaves short-petioled; anthers bearded .... *38. M. dentatus*
     ** Leaves sessile, anthers glabrous .... *37. M. sessilifolius*
    2. Calyx-teeth unequal, the two lower teeth longer than the three others .... *48. M. alsinoides*
   II. Calyx-throat not oblique.
    1. Mature calyx with corky ribs .... *55. M. bicolor*
    2. Mature calyx without corky ribs.
     * Style pubescent.
      † Internodes shorter than the leaves; corolla reddish-purple .... *62. M. purpureus*
      †† Internodes longer than the leaves; corolla yellow .... *41. M. washingtonensis*
     ** Style glabrous.
      † Leaves distinctly petioled.
       ‡ Leaves narrowly oblong .... *40. M. Pulsiferae*
       ‡‡ Leaves ovate.
        § Stems viscid-puberulent .... *42. M. ampliatus*
        §§ Stems viscid-villous .... *50. M. Dudleyi*

†† Leaves sessile.
‡ Anthers hispid................................*64. M. discolor*
‡‡ Anthers glabrous.
§ Corolla-lobes narrow, emarginate............*66. M. deflexus*
§§ Corolla-lobes broad, not emarginate.
0 Pedicels much exceeding the leaves; corolla rose-purple..............................*59. M. gracilipes*
00 Pedicels rarely exceeding the leaves; corolla yellow..............................*65. M. montioides*

b. Corolla-lobes equal or subequal.
α. Perennials.
I. Flowers solitary, scapose......................*54. M. primuloides*
II. Flowers racemose.
1. Plants glabrous or nearly so; anthers glabrous....*47. M. Leibergii*
2. Plants not glabrous; anthers bearded.
* Stems glandular-pubescent; corolla red or pink.
† Stems erect; corolla pink........................*52. M. Lewisii*
†† Stems prostrate; corolla red................*53. M. Eastwoodiae*
** Stems more or less slimy; corolla yellow........*46. M. moschatus*
β. Annuals.
I. Calyx-ribs corky when mature......................*56. M. Bioletti*
II. Calyx-ribs not corky.
1. Anthers hispid.
* Calyx-teeth equal, ciliate........................*57. M. Palmeri*
** Calyx-teeth unequal, glabrous..................*58. M. filicaulis*
2. Anthers glabrous.
* Pedicels at least 3 times the length of the leaves.
† Corolla more than 1 cm. long....................*61. M. diffusus*
†† Corolla less than 1 cm. long.
‡ Capsule longer than the calyx................*63. M. exiguus*
‡‡ Capsule shorter than the calyx............*60. M. androsaceus*
** Pedicels less than 3 times the length of the leaves.
† Plants glandular-pubescent or glandular-villous.
‡ Stems stout, 1.5–4 dm. high.................*51. M. Parishii*
‡‡ Stems slender, 2–15 cm. high.................*67. M. Breweri*
†† Plants glabrous or minutely-puberulent.
‡ Calyx-teeth glabrous; stigma-lobes unequal..*68. M. Suksdorfii*
‡‡ Calyx-teeth mostly ciliate; stigma-lobes equal..*69. M. rubellus*

26. M. repens R. Br. Prodr. 439. 1810, and 123. 1821; Benth. Scroph. Ind. 29. 1835; DC. Prodr. **10**: 373. 1846; Benth. & Mueller, Fl. Austr. **4**: 482. 1869; Hooker in Curtis, Bot. Mag. III. **20**: *pl. 5423.* 1864; Moore, Fl. New South Wales, 337. 1893; Rodway, Fl. Tasmania, 138. 1903; Cheeseman, Fl. New Zealand, 484. 1906.

M. Colensoi Kirk in Trans. N. Z. Inst. **3**: 179. 1871.

A low-growing, glabrous, succulent perennial; stems 3–10 cm.

long, stout, creeping, rooting from the nodes, freely branching, the branches prostrate or ascending; internodes shorter than the leaves; leaves numerous, broadly oblong or oval, obtuse, 2–4 mm. long, 1–3 mm. wide, thick, entire, sessile by a broad base, 1-nerved, often with smaller leaves fascicled in the axils, pitted when dry; flowers few, axillary and solitary, pedicels stout, rarely exceeding the leaves; calyx narrowly campanulate, 4 mm. long, ribs and teeth green with a reddish-purple crenate lobe between, much distended by the mature capsule, teeth equal, short, triangular-acute; corolla broadly funnelform, 1.2–1.5 cm. long, blue or lilac, tube paler in color, sometimes nearly white, exserted, expanding abruptly to a wide throat, lobes long, broad, wavy-margined, unequal, the lower lip pale lilac, with a yellow area down the throat, this densely hairy and spotted with red, palate prominent, partly closing the throat; stamens included, glabrous, the filaments enlarged at the base; style glabrous, as long as the throat, sometimes with a thickened knob at the base, stigma-lips oblong, equal; capsule included, obtuse, constricted below, dehiscent along the upper suture and part way down the lower, placentae adherent to the apex; seeds oval, longitudinally striate.

Distribution: common in salt marshes and muddy places in Australia, Tasmania, and New Zealand.

Specimens examined:

Australia: without date, *Mueller* (G, Cornell, and M).

South Australia: Port Lincoln, without date, *Schomburgh* (U. S.).

Victoria: Point Lonsdale, Oct.–Nov., 1912, *Tilden 726* (G and M); Upper Yarra, Feb., 1882, *Walter* (M); Colony of Victoria, Sept., Dec., 1854, *Harvey* (G).

Tasmania: without date, *Hooker* (G).

New Zealand: Onehunga, North Island, without date, *Kirk 124* (G); Lake Ellesmere, South Island, without date, *Kirk* (M).

27. M. orbicularis Wall. Cat. *No. 3919*. 1828; Benth. Scroph. Ind. 29. 1835; DC. Prodr. **10**: 373. 1846; Hook. Fl. Brit. Ind. **4**: 259. 1884.

Creeping, glabrous, somewhat succulent perennials, rooting from the nodes; stems stout, 1–2.5 dm. long; leaves petiolate, thick, orbicular, 2–2.5 cm. wide, entire, not veined; pedicels

shorter or as long as the leaves; calyx 6 mm. long, almost truncate, teeth very short; corolla blue, 1.2–1.8 cm. long; style stout; capsule exserted, elliptical, acute.

Distribution: southeastern India.

28. **M. prostratus** Benth. in DC. Prodr. **10**: 373. 1846; Benth. & Mueller, Fl. Austr. **4**: 483. 1869; Moore, Fl. New South Wales, 337. 1893.

A prostrate, creeping perennial; stems pubescent, 2–15 cm. long, profusely branched; leaves crowded, narrowly oblong, obtuse, 8–13 mm. long, 2–4 mm. wide, entire, sessile by a broad base, thick, 1-nerved, grayish-green, mostly glabrous; flowers axillary, solitary, pedicels pubescent, shorter than the leaves; calyx tubular, more or less pubescent, 5–6 mm. long, becoming 7–8 mm. long when mature, not inflated, teeth short, triangular-acute, sparsely ciliate; corolla 8–11 mm. long, violet, tube slender, exserted, yellow, throat broad, glabrous within, ventricose, lobes subequal, rotate, reticulately veined; stamens included, glabrous; style as long as the corolla, pubescent above, stigma peltate-funnelform, lips equal; capsule included, broadly oval, obtuse, dehiscent along both sutures, breaking away irregularly from near the base; seeds subglobose, reticulate.

Distribution: Victoria and New South Wales, Australia.

Specimens examined:

New South Wales: Nymagee, Nov., 1903, *Boorman* (Pomona); Zara, Wanganella, Dec., 1919, *Officer* (Wellesley); Tomingley to Narromine, Sept., 1898, *Maiden* (G).

Victoria: Murray River, 1871, *Mueller* (M); Swan Hill, Oct., 1888, *French* (G).

The plants of this species are very brittle when dried.

29. **M. pusillus** Benth. in DC. Prodr. **10**: 369. 1846.

Small, creeping, grayish-green perennials, densely pubescent with soft white hairs; stems freely branching, 2–3 cm. high; leaves few, narrowly oblong or oval, 1–2 mm. long, sessile, thick, obscurely 1-nerved, entire; flowers solitary, mostly terminal, with long, slender pedicels, these sometimes almost as long as the plant; calyx narrowly campanulate, 3–4 mm. long, teeth very

short, triangular-acute, nearly equal, ciliate; corolla 9–10 mm. long, tube slender, much exserted, yellow, throat expanded, apparently glabrous within, slightly constricted at the apex, lobes blue, rounded, somewhat rotately spreading; stamens included, glabrous; style almost as long as the corolla, pubescent, stigma-lips broadly rounded, equal, with a laciniate margin; capsule broadly obovate, obtuse, the valves dehiscent along both sutures and breaking away near the base, placentae adherent; seeds subglobose, reticulate.

Distribution: wet places in the southern part of Australia.

Specimens examined:

New South Wales: Darling River, without date, *Mueller* (G).

30. **M. breviflorus** Piper in Bull. Torr. Bot. Club 28: 45. 1901; Fl. Southeast Wash. and Adj. Idaho, 228. 1914; Howell, Fl. Northwest Am. 521. 1901; Rydb. Fl. Rocky Mountains, 779. 1917.

Stem slender, 3–15 cm. long, freely branched, branches erect or slightly spreading, puberulent; leaves rhombic-ovate or oblanceolate, .5–1.5 cm. long, 2–4 mm. wide, narrowing to a slender petiole, denticulate or rarely entire, 1–3-nerved; pedicels mostly erect, slender, usually slightly longer than the leaves, puberulent; calyx tubular, 3–5 mm. long, becoming enlarged and somewhat inflated in fruit, 5–7 mm. long, 3–4 mm. wide, teeth short, equal, deltoid-acute, frequently subulate, sparsely hispid, slightly constricted at the orifice when mature; corolla 4–7 mm. long, pale yellow, tube included, lobes nearly equal, truncate, entire; stamens filiform, included, white, glabrous; style short, glabrous, scarcely longer than the calyx, stigma-lips nearly equal; capsule included, oblong, slightly stipitate, placentae adherent to the apex; seeds oval, favose-pitted.

Distribution: wet places in Idaho, Washington, and Oregon.

Specimens examined:

Idaho: Lake Waha, Nez Perces Co., 2500–3000 ft. alt., 24 June, 1896, *Heller & Heller 3320* (Cornell, M, and Stanford); sunny stream margin, Silver City, Owyhee Co., 7000 ft. alt., 17 June, 1911, *Macbride 900* (M, R. Mt., and Stanford); Julietta, Latah Co., June, 1892, *Sandberg, MacDougal & Heller 347*

(G and Pomona); moist dirt banks, Martin, Blaine Co., 6200 ft. alt., 7 July, 1916, *Macbride & Payson 3093* (G, M, and R. Mt.); pond borders, University grounds, Moscow, 28 Aug., 1897, *Henderson 4610* (Cornell).

Washington: Rock Lake, Whitman Co., 30 May, 1893, *Sandberg & Leiberg 115* (U. S); patches in springy places, Wawawai, Whitman Co., May, 1897, *Elmer 774* (M and R. Mt.); river bank, Bingen, Sept.–Dec., 1901, 1904, *Suksdorf 4472* (Stanford); Yakima Co., June, 1892, *Henderson 2264* (G); Yakima Region, Northern Transcontinental Survey, 1882, *T. S. Brandegee 206* (M); damp places, Falcon Valley, 2 July, 1885, *Suksdorf 485* (M and G); Pullman, 15 June, 1894, *Piper 1826* (G); Pullman, 3 July, 1894, *Piper 1858* (G, *type collection*); low sandy banks of the Columbia River, W. Klickitat Co., Sept., 1883, *Suksdorf 203* (G).

Oregon: moist fields, Hood River, 1883, *Henderson* (G); Hood River, 1884, *Barrett* (G).

31. **M. latidens** (Gray) Greene, Manual Bay Region, 278. 1894; Jepson, Fl. W. Mid. Calif. 406. 1902, and ed. 2, 379. 1911.

M. inconspicuus var. *latidens* Gray, Syn. Fl. N. Am. ed. 2, 2^1: Suppl. 450. 1886.

Plants glabrous or nearly so; stem 1–2.5 dm. high, simple or usually with several erect or spreading basal branches; leaves broadly ovate, 1–3 cm. long, .5–1.2 cm. broad, acute, commonly sessile, entire or obscurely toothed, thin, much longer than the internodes, basal leaves often subrosulate and short-petioled; pedicels erect, slender, reddish, sometimes obscurely puberulent, longer than the flowers and becoming much elongated in fruit; calyx cylindrical, 7–8 mm. long, accrescent, broadly oval when mature, strongly plicate and much constricted at the oblique orifice, 10–12 mm. long, 6–7 mm. broad, loosely investing the capsule; teeth 1–1.5 mm. long, triangular-acute, obscurely ciliate, connivent, nearly closing the throat; corolla 9–11 mm. long, white or yellowish, often tinged with pink, tube broad, included, throat short, broad, lobes erect, 1.5–2 mm. long, nearly equal, truncate; stamens included, glabrous, filaments slender, flat,

winged; style shorter than the ovary, 1–2 mm. long; stigma-lips unequal; capsule obovate or oval, stipitate; seeds oval, papillate.

Distribution: low wet fields from northern California to Lower California.

Specimens examined:

California: Chico-Hamilton Road, 6 miles from Chico, 1 May, 1914, *Heller 11343* (Cornell, M, Ore., Calif., and Stanford); Little Chico Creek, Butte Co., 1896, *Austin 164* (M and Calif.); Lower Sacramento, 2–6 May, 1891, *Jepson* (R. Mt. and Calif.); Lower Napa Valley, 27 April, 1893, *Jepson 31m* (Calif.); Montezuma Hills, Solano Co., 14 May, 1892, *Jepson 32m* (Calif.); Bartlett Mt., May, 1884, *T. S. Brandegee* (Calif.); Little Oak, Vacaville, Solano Co., April, 1889, *Jepson 33m* (Calif.); near Mt. Diablo, 26 May, 1862, *Brewer 1161* (G, TYPE, U. S., and Calif.); Mt. Diablo, 1884, *Curran* (G); Antioch, May, 1886, *Curran* (M and Calif.); Antioch, May, 1888, *T. S. Brandegee* (Phil., M, and Stanford); Antioch, May, 1889, *T. S. Brandegee* (Calif.); Antioch, 7 April, 1885, *Davy 933* (Calif.); wet depressions in adobe, between Antioch and Marsh Creek, 5 May, 1907, *K. Brandegee* (Calif.); between San Benito River and Bitterwater, San Benito Co., 2700 ft. alt., 21 May, 1915, *H. M. Hall 9907* (Calif.); Kaweah, Tulare Co., 27 May, 1895, *Eastwood* (G); Menifee Valley, Riverside Co., 19 June, 1922, *Munz & Johnston 5378* (Pomona); Chollas, San Diego Co., 20 June, 1884, *Orcutt 1179* (G and M).

Mexico:

Lower California: Hansen's, Lower California, 7 July, 1885, *Orcutt* (M); Santo Tomas, northern Lower California, 17 April, 1886, *Orcutt* (M); mountains, Lower California, 7 July, 1885, *Orcutt* (M); Santo Tomas, northern Lower California, 21 April, 1886, *Orcutt* (M).

32. M. acutidens Greene in Bull. Calif. Acad. Sci. **1**: 117. 1885; Eastwood, Fl. South Fork King's River, Sierra Club Publ. 27:66. 1902.

M. inconspicuus var. *acutidens* (Greene) Gray, Syn. Fl. N. Am. ed. 2, 2^1: Suppl. 450. 1886.

Mostly glabrous annuals; stem 7–20 cm. high, slender, erect

or diffusely branched, slightly quadrangular and winged; leaves in few pairs, broadly ovate, 1–2 cm. long, 7–11 mm. wide, sessile by a broad base, thin, 3–5-nerved from the base, denticulate, occasionally hirsute, internodes 2–4 times as long as the leaves; pedicels slender, almost filiform, much longer than the leaves, curved, divaricate, often deflexed; calyx narrowly campanulate, 5–6 mm. long, in fruit chartaceous, 7–9 mm. long, 3–4 mm. wide, teeth short, triangular, sharply subulate, ciliate, equal; corolla bilabiate, 1.3–1.5 cm. long, pale pink to rose-purple, tube slightly exserted, throat narrowly funnelform, deep pink on the outside with two yellow spots below the lower lip, lobes unequal, usually emarginate, spreading, paler pink, often more or less tinged with yellow; stamens included, filaments glabrous, anthers subglobose, villous; style glabrous, included, stigma-lips equal; capsule short-stipitate, oblong, obtuse, placentae separating at the apex.

Distribution: in the foothills of the Sierra Nevada Mts., from Fresno Co. to Tulare Co., California.

Specimens examined:

California: King's River Mountains, 4000 ft. alt., April, 1877, *Eisen* (G, *type collection*); Toll House, Fresno Co., 2050 ft. alt., 13 June, 1904, *Hall & Chandler 21* (U. S., M, and Stanford); roadside between Dunlap and Pinehurst, Fresno Co., 24 May, 1921, *Ottley 1356* (Wellesley, Cornell, and M); Limekiln Creek, Tulare Co., 23 May, 1907, *Jepson 2797* (Calif.); Eschom Creek Redwoods, Kaweah River Valley, 23 July, 1896, *Dudley 1382* (Stanford).

33. **M. Grayi** Grant[1] Pl. 6, fig. 2.

M. acutidens Hall, Yosemite Fl. 223. 1912, not Greene.

Glabrous or nearly glabrous annuals, simple or branched from the base; stem 8–20 cm. high, slender, somewhat quadrangular, internodes long, usually several times the length of the leaves;

[1] **Mimulus Grayi Grant, sp. nov., annuus valde glabrus; caulibus tenuibus, 8–20 cm. altis, internodiis elongatis, plus minusve quadrangularibus; foliis paucis, late ovatis, acutis, sessilibus, base latis, 3–5-nervibus; pediculis foliis brevioribus; calyce 6–7 mm. longo, late ovato in fructu, 9–10 mm. longo, 5–6 mm. lato, dentibus ciliatis, brevibus, mature fere truncatis; corolla rosea, 1.2–1.5 cm. longa, lobis inaequalibus, antheris villosis, subglobosis; stigmae laciniis inaequalibus; capsula stipitata.—Collected at Mariposa, May, 1882, *Congdon* (Gray Herb., TYPE).**

leaves few, broadly ovate, .7–1.8 cm. long, .5–1.2 cm. wide, thin, acute, denticulate, sessile by a broad base, 3–5-nerved, rarely puberulent; inflorescence racemose, often flowering from near the base; pedicels slender, shorter than the leaves, spreading; calyx puberulent, 6–7 mm. long, broadly oval in fruit, 9–10 mm. long, 5–6 mm. wide, chartaceous, strongly plicate, teeth equal, ciliate, very short, broad, tapering abruptly to a short point, giving a truncate appearance to the mature calyx; corolla slightly bilabiate, 1.3–1.5 cm. long, rose-red, tube exserted, throat expanded, pink with a yellow patch lined with rose-red, two yellow, hairy ridges below the lower lip, lobes short, emarginate, more or less hirsute at the base; stamens included, white, filaments glabrous, anthers subglobose, villous with soft white hairs; style included or slightly exserted, glabrous, stigma-lips unequal; capsule chartaceous, oblong, obtuse, almost truncate at the apex, stipitate, placentae separating nearly one-fourth the entire length; seeds oval, favose-areolate.

Distribution: in the Sierra Nevada Mts. from Yosemite Valley to Tulare Co., California.

Specimens examined:

California: Alder Creek Trail, Yosemite Park, 5500 ft. alt., 1 July, 1911, *Jepson 4321* (Cornell, M, and Calif.); Raymond to Yosemite, 11 June, 1891, *Fritchey 3* (M); Snow Creek, Yosemite Park, 10 July, 1883, *Congdon* (G); Mariposa, May, 1882, *Congdon* (G, TYPE); Darrah, Mariposa Co., 3 July, 1892, *Congdon* (Stanford); Mariposa, 16 May and 17 June, 1892, *Congdon* (Stanford); near Sugar Pine Mill, Madera Co., 12 July, 1901, *Dudley* (Stanford); Coffee Pot Pasture near spring in black soil, vicinity of Homer's Nose, Sequoia Nat. Forest, 9000 ft. alt., 12 July, 1897, *Dudley 1799* (Stanford); Cedar Creek, Sequoia Park, 4000 ft. alt., 20 June, 1900, *Jepson 591* (Calif.); near Cedar Creek, Giant Forest, Tulare Co., 26 July, 1905, *K. Brandegee* (R. Mt. and Pomona); in dry, shady places, Cedar Creek, 4 July, 1902, *G. B. Grant 2345* (Stanford); California, without date, *Bridges 199* (N. Y.).

34. M. inconspicuus Gray in Pac. Rail. Rept. **4**: 120. 1857; Proc. Am. Acad. **7**: 380. 1867; *ibid.* **11**: 99. 1876; Bot. Calif. **1**:

568. 1876, in part; Syn. Fl. N. Am. 2[1]: 278. 1878, ed. 2, and Suppl. 449. 1886, in part; Greene in Bull. Calif. Acad. Sci. 1: 116. 1885, in part.

Stem glabrous, 5–16 cm. high, somewhat quadrangular with winged angles simple or freely branched from the base; leaves oval or mostly ovate, .8–2 cm. long, .6–1.2 mm. wide, all but the lowest sessile by a broad base, entire or sparingly denticulate, indistinctly 1–3-nerved; pedicels generally erect, slender, longer or shorter than the leaves; calyx 5–6 mm. long, glabrous or minutely puberulent, narrowly campanulate, becoming oval and chartaceous in fruit, 6–7 mm. long, 3 mm. wide, teeth slightly unequal, short, broad, mucronate, giving the mature calyx a somewhat truncate appearance, ciliate; corolla somewhat bilabiate, .8–1 cm. long, rose-pink to pale pink with a yellow streak bordered with rose-pink below the lower lip, tube included, throat funnelform, lobes deeply emarginate, erect, or the lower lip somewhat spreading; stamens included, white, anthers villous with scattered long white hairs; style slightly exserted, stigma-lips unequal, infundibuliform; capsule included, oval, acute at both ends, stipitate, placentae separating at the apex; seeds oval, apiculate at one end.

Distribution: in moist or shaded places in the central and southern Sierra Nevada Mts., and in southern California.

Specimens examined:

California: Grass Valley, Amador Co., 2500 ft. alt., 2 May, 1895, *Hansen 1126* (U. S.); Agricultural Station, Amador Co., 2000 ft. alt., May, 1893, *Hansen 1290* (M and Stanford); Italian Bar, South Fork Stanislaus River, Tuolumne Co., 5 June, 1915, *Jepson 6371* (Calif.); Columbia, Tuolumne Co., 2200 ft. alt., 1 June, 1915, *Jepson 6341* (Cornell, M, and Calif.); Geological Survey of California, 1866, *Rattan 217* (G and U. S.); damp hillsides, Los Angeles, 14 May, 1854, *Bigelow* (G, TYPE, N. Y., and Phil.).

This is the most common species in a closely related group of plants consisting of *M. inconspicuus*, *acutidens*, *latidens*, and *Grayi*. Dr. Gray considered them to be conspecific, but later he gave varietal status to *acutidens* and *latidens*. The original material of *M. Grayi* was designated by Dr. Gray under the un-

published varietal name of "truncatus." They all have leaves closely sessile by a broad, 3–5-nerved base, strongly plicate, inflated mature calyces with short broad teeth, subglobose villous anthers, and stipitate capsules.

35. **M. nepalensis** Benth. in Wall. Cat. no. 3917. 1828; Scroph. Ind. 29. 1835; DC. Prodr. **10**: 373. 1846; G. Don, Hist. Dichlam. Pl. **4**: 554. 1838.

M. assamicus Griff. in Madr. Jour. Sci. **4**: 375. 1836; Notulae **4**: 99. 1854; Linnaea **12**: litt. 199. 1838; Walp. Rep. **3**: 277. 1844–45.

M. tenellus Bunge, Pl. Enum. China, 49. 1831; Benth. DC. Prodr. **10**: 373. 1846; Walp. Rep. **3**: 277. 1844–45.

M. formosana Hayata in Ic. Pl. Formos. **9**: 79. 1920.

A nearly glabrous perennial; stems quadrangular, the angles winged, slender, weak, often diffusely branched, rooting from the nodes; leaves ovate or ovate-oblong, 1.5–4 cm. long, .5–2 cm. broad, acute, saliently dentate, base cuneate or tapering gradually to a short petiole, pinnately veined; pedicels slender, about as long as the leaves, occasionally pubescent; calyx cylindrical, 7–10 mm. long, inflated in fruit and 1.1–1.4 cm. long, 3–7 mm. broad, usually somewhat constricted at the throat, teeth ciliate, nearly equal, truncate or short and broad with slender abruptly pointed tips, occasionally pubescent along the ribs, ribs sometimes slightly winged, throat oblique in some flowering specimens; corolla .8–2 cm. long, yellow, funnelform, little exceeding the calyx, tube exserted, throat ampliate, densely bearded along the lower side, often dotted with red, lobes short, rounded, erect; stamens and style glabrous, included, stigma-lips equal, fimbriate; capsule oblong, placentae adherent to the apex; seeds oval, minutely papillate and occasionally with a few scattered hairs.

Distribution: wet places in Japan, China, and India.

Specimens examined:

Japan: Sapporo, 10 July, 1903, *Arimoto* (G); Yezo, Sapporo, 27 Aug., 1902, *Arimoto* (G); Sapporo, 25 Aug., 1887, *Tokubuchi* (Phil.); Hakone, May, 1886, *Tokio Education Museum 343* (U. S.); Aidzu, 7 Aug., 1879, *Matsumura* (U. S.).

China: Meng-tsze, Yunnan, without date, *Henry 10450* (U. S.); W. Hupeh, June, 1900, *Wilson 1302* (U. S.); Hupeh, 1885–1888, *Henry 5897* (U. S.); Hupeh, 1885–1888, *Henry 7445* (G).
Manchuria: Valley J-cze-sun-che, District Onioso, Province Kirinensis, 7 Aug., 1896, *Komarov* (G).
India: Himalayas, without other data (Phil.).

The inflated calyx in mature specimens and the small corolla of this species indicate relationship to *M. inconspicuus*, a species confined to California. From this, it differs in having shorter calyx-teeth, a yellow corolla with entire lobes, and glabrous anthers.

35a. Var. **japonica** Miq. ex Maxim. in Bull. Acad. St. Petersburg **20**: 436. 1875.

M. nepalensis forma *japonica* Miq. Prol. 48. 1866–67.

Leaves mostly smaller than in the species, 1.5–2.5 cm. long, .8–1.6 cm. wide; fruiting pedicels longer than the leaves; calyx-tube cylindrical, not broadly inflated, teeth subequal, the two upper somewhat larger than the others; corolla 1.5–2 cm. long.

Distribution: wet places in Japan and India.

Specimens examined:

Japan: Nanokawa, Tosa, July, 1892, *Mizo-hoduki* (U. S.).
India: Pungbee, Sikkim, 500 ft. alt., 28 June, 1870, *Clarke 12114* (U. S.); Sikkim, 7000 ft. alt., May, 1877, *Lister* (U. S.); Sikkim, 4000–10000 ft. alt., 1848–49, *Hooker* (G).

Differs from the species mainly in size and in the length of the pedicels, these being longer than the leaves.

35b. Var. **procerus** Grant[1] Pl. 3, fig. 2.

Stems simple, erect, 2–3.5 dm. long, not winged; leaves broadly ovate or elliptical, 1.5–3.5 cm. long, 1–2 cm. broad, short-petioled, coarsely toothed; fruiting calyx broadly campanulate, 1.3–1.4 cm. long, ribs pubescent, subequal, the upper tooth sometimes longer than the others; corolla 2.5–3 cm. long, throat broadly funnelform, spotted with red; capsule not seen.

[1] **Mimulus nepalensis** Benth. var. **procerus** Grant, var. nov., caules simplices, erecti, 2–3.5 dm. longi, non alati; foliis late ovatis, 1.5–3.5 cm. longis, 1–2 cm. latis, petiolis brevibus; corolla 2.5–3 cm. longa.—Collected in Sikkim Himalaya, India, 1 Aug., 1892, *G. A. Gammie* (U. S. Nat. Herb. no. 262003, TYPE).

A larger plant with erect, unbranched stems and larger flowers, merging into *M. nepalensis* through such specimens as *Clarke 12114* from Sikkim. It closely resembles *M. dentatus*, a Pacific Coast species, differing from it mainly in having a smaller and less ampliate corolla which is not constricted at the base of the throat.

Distribution: in wet places in Sikkim, India.

Specimens examined:

India: Sikkim Himalaya, 1 Aug., 1892, *Gammie* (U. S., TYPE); Sikkim, 4000–10000 ft. alt., 1848–49, *Hooker* (G).

36. **M. Bodinieri** Vaniot in Bull. Acad. Geog. Bot. **15**: 86. 1905.

Low, glabrous, creeping perennials, freely rooting from the nodes; stems prostrate or procumbent, 1–2 dm. long, simple or with short branches, quadrangular, the angles more or less winged; leaves broadly ovate, 1–3 cm. long, .5–1.5 cm. wide, acute, mucronate, minutely and sparsely denticulate, pinnately veined, sessile by a broad, clasping subcordate base, rarely short-petioled; flowers few, axillary, pedicels weak, longer than the leaves; calyx campanulate, 6–10 mm. long, ciliate, throat slightly oblique, teeth short, broadly triangular, mucronate; corolla yellow, 1.3–1.5 cm. long, throat exserted, lobes nearly equal, slightly spreading; style included, glabrous, stigma-lips equal; capsule obovate, obtuse; seeds subglobose.

Distribution: in standing water, southern China.

Specimens examined:

China: Yunnan, near Likiang, about 8500 ft. alt., 8 July, 1914, *Schneider 1771* (U. S.); in the region of Likiang, near Pegu-Ngu-lch-keh, about 8700 ft. alt., 18 July, 1914, *Schneider 1863* (U. S.).

37. **M. sessilifolius** Maxim. in Bull. Acad. Sci. St. Petersburg **20**: 436. 1875; Gray, Syn. Fl. N. Am. ed. 2, **2**[1]: Suppl. 447. 1886.

A glabrous or almost glabrous perennial, stems erect or flaccid, somewhat quadrangular; leaves broadly ovate, 2–7 cm. long, 1.5–3 cm. wide, closely sessile, 5–7-nerved from the base, lower acute, upper smaller and obtuse or rounded above, all saliently

toothed, the upper with large teeth, mostly puberulent at the nodes; pedicels slender, shorter than the leaves; calyx campanulate to funnelform, 1–1.2 cm. long, teeth deltoid-acute, 2–3 mm. long, subequal, ciliate; corolla bilabiate, 3 cm. long, funnelform, yellow, throat ampliate, exserted, about twice as long as the calyx, lobes subequal, rounded, 8–10 mm. long; stamens and style included, glabrous, filaments thin, flattened; capsule oblong, dehiscent to the base, placentae adherent; seeds broadly oval, longitudinally wrinkled.

Distribution: wet places in Japan.

Specimens examined:

Japan: Togakushi-san, Province Shinano, 12 June, 1894, without name of collector (U. S.); Suttsu, Prov. Oshima, 19 July, 1888, *Tokubuchi* (Phil.); Sapporo, 22 June, 1884, *Tokubuchi* (G); Mori, 4 June, 1885, *Père Fourie 327* (M).

This species is closely related to *M. dentatus* and *M. nepalensis* but differs from them in its closely sessile and 5–7-nerved leaves.

38. **M. dentatus** Nutt. ex Benth. in DC. Prodr. **10**: 372. 1846; Gray in Bot. Calif. **1**: 567. 1876; Syn. Fl. N. Am. ed. 2, **2**[1]: Suppl. 447. 1886; Greene in Bull. Calif. Acad. Sci. **1**: 109. 1885; Howell, Fl. Northwest Am. 519. 1901; Piper, Contr. U. S. Nat. Herb. **11**: 509. 1906.

Perennial from running rootstocks and with pubescent stolons above ground, rooting at the nodes; stem simple, erect, 1.5–3.5 dm. high, sparsely villous; leaves broadly ovate, 2–7 cm. long, 1.2–3.5 mm. wide, acute, tapering to a short petiole, sparingly pubescent, coarsely and saliently dentate on the upper half, often tinged with red; pedicels slender, pubescent, shorter than the leaves; calyx campanulate, 1.1–1.5 cm. long, sparsely villous along the acutely angled ribs, teeth triangular-acuminate, 4–6 mm. long, ciliate, subequal, throat oblique; corolla 3.5–4.5 cm. long, golden-yellow, tube short, included, constricted at the apex, throat almost as broad as long, ventricose, spotted with brown on the lower side, lobes rounded, 6–12 mm. long, usually erect, sometimes emarginate, sinuses broad; stamens included, filaments glabrous, anthers villous; style and stigma glabrous, included, stigma-lips rounded, equal, fimbriate; capsule oblong, included, placentae adherent; seeds oval, favose-pitted.

Distribution: in woods and along streams from Washington to northern California.

Specimens examined:

Washington: Columbia River, *Nuttall* (G, TYPE); Montesano, Chehalis Co., 200 ft. alt., 10 June, 1898, *Heller & Heller 3926* (Phil. and M); along streams, Montesano, May, 1917, *J. M. Grant* (M); North Branch, Pacific Co., 16 Aug., 1903, *Sheldon S12959* (Stanford); wet rocks, wet places in dense forests at Altoona on the Columbia River, 20 July, 1909, *Suksdorf 6673* (G).

Oregon: near Astoria, 12 May, 1892, *Howell* (M); Falls City, 8 May, 1915, *J. C. Nelson 120* (Stanford); Brookings, May, 1915, *J. H. Thompson 178* (Stanford); Tillamook, 10 Sept., 1894, *Lloyd* (N. Y.); Toledo, 7 Aug., 1909, *Rusby* (N. Y.); Coast Mts., July, 1882, *Howell* (Phil.); damp bank, 3 miles above mouth of Chetco River, Curry Co., 12 July, 1919, *Peck 8810* (M); Corvallis environs, May, 1922, *Epling 5549* (Epling); Yaquina, 28 July, 1922, *Epling 5554* (Epling).

California: Humboldt Bay, 1000 ft. alt., May, 1901, *Chandler 1199* (N. Y., M, Calif., and Stanford); Humboldt Co., 1882, *Rattan* (G and M); in moist places, Freshwater Creek, Humboldt Co., very common in the forests of Humboldt and Del Norte Co's., June, 1882, *Rattan 25* (G); Coast Mts., north of San Francisco Bay, June, 1882, *Rattan* (M); Humboldt Co., 1911, *H. H. Smith 3791* (M); wet ground under redwoods, Eureka, 31 May, 1896, *Blasdale* (R. Mt.); Humboldt Co., 1879, *Rattan* (Stanford); Humboldt Bay, June, 1882, *Rattan* (Calif. and Stanford); near Crescent City, without date, *Rattan* (Stanford); Klamath River, Del Norte Region, June, 1899, *Dudley* (Stanford); common in shaded moist ground, vicinity of Eureka, 30 May, 1900, *Tracy 833* (Calif.).

39. **M. Bridgesii** (Benth.) Clos in C. Gay, Hist. Chile **5**: 141. 1849; Walp. Ann. **3**: 193. 1852–53; Reiche, Fl. Chile 6^1: 63. 1911.

M. parviflorus β *Bridgesii* Benth. in DC. Prodr. **10**: 371. 1846.

Glabrous perennials, freely rooting at the nodes; stems ascending or erect, 1–3 dm. long; leaves few, ovate or oval, 1.2–3.5 cm.

long, .5–2 cm. broad, obtuse, dentate or erose, 3–5-nerved from the base, upper leaves sessile by a broad clasping base, the lower sessile or short-petioled; pedicels slender, elongated, 2–4 times the length of the leaves; calyx campanulate, 7–8 mm. long, tinged with red, sometimes minutely puberulent, much inflated and oval in fruit, the top appearing as though truncate, teeth broadly triangular-acute, 1 mm. long, nearly equal, the orifice scarcely oblique; corolla 1.5–2.2 cm. long, broadly funnelform, the lower lip and open throat spotted with red, lobes unequal, little spreading; style glabrous, stigma-lips oblong, nearly equal; capsule included, elliptical, acute, short-stipitate, placentae separating at the apex; seeds smooth, oval, less than twice as long as broad, not apiculate.

Distribution: in wet places from central to southern Chile.

Specimens examined:

Chile: Colchagua, 1862, *Bridges* or *Cuming* ? (U. S.); Cauquenes, without date, *Reid* (G); stagnant ditch, Valdivia, 12 Nov., 1904, *Buchtien 109* (Calif.); without further data, *Dr. Styles* (Phil.).

Clos has described two varieties: (1) *stolonifera*, tall plants with remote leaves, either short or long-petioled, acute and erose-dentate; (2) *integrifolia*, small plants, leaves close together, sessile, subconnate, nearly entire. Material of these varieties has not been seen by the writer. *M. longipes* Ph. in Linnaea **29**: 28. 1857–58, is probably a synonym of the variety *integrifolia*.

40. M. Pulsiferae Gray in Proc. Am. Acad. **11**: 98. 1876; Bot. Calif. **1**: 568. 1876; Syn. Fl. N. Am. **2**[1]: 277. 1878, ed. 2, and Suppl. 450. 1886; Greene in Bull. Calif. Acad. Sci. **1**: 115. 1885; Howell, Fl. Northwest Am. 521. 1901; Piper, Contr. U. S. Nat. Herb. **11**: 510. 1906. Pl. 10, fig. 10.

Stems slender, 5–15 cm. high, glandular-puberulent, simple or more often loosely branched from the base; leaves short-petioled, narrowly oblong or occasionally spatulate, .8–2.2 cm. long, 4–10 mm. broad, acute, base cuneate or acute, entire or irregularly denticulate, puberulent; pedicels filiform, shorter than the corolla, becoming elongated and somewhat curved and spreading in fruit, usually much longer than the leaves; calyx narrowly tubular,

5–7 mm. long, accrescent, 9 mm. long in fruit, rarely inflated, teeth equal or nearly so, triangular-acute, 1 mm. long, sometimes becoming constricted at the throat and slightly connivent, margins sparingly hispid; corolla 7–11 mm. long, yellow, tube exserted, funnelform, lobes short, erect, unequal, truncate, entire or notched, sometimes tinged with pink or with a single large red spot below the middle lobe of the lower lip; stamens glabrous, filaments flattened, included; style glabrous, included; stigma-lips oblong, nearly equal; capsule slightly oblong, often as long as the calyx, placentae not separating; seeds oval, smooth.

Distribution: Washington to northern California.

Specimens examined:

Washington: damp low grounds, Falcon Valley, June, 1885, *Suksdorf* (M and Stanford); damp low grounds, Falcon Valley, 10 June–30 July, 1885, *Suksdorf 486* (G); damp low bare grounds near Trout Lake, Klickitat Co., 26 July, 1886, *Suksdorf* (G).

Oregon: bar of Columbia River, 1884, *Barrett* (G); margin of pond, 1 mile east of Waldo, Josephine Co., 22 June, 1918, *Peck 7935* (G); Grant's Pass, May, 1884, *Howell 236* (G); Big Meadow, Des Chutes River, about 4500 ft. alt., 23 July, 1894, *Leiberg 491* (G).

California: Metcalf's Ranch, base of Mt. Eddy, Siskiyou Co., June, 1920, *Heller 13391* (M); Sierra Valley, *Bolander & Kellogg* (G); near Shasta Springs, Siskiyou Co., 5 June, 1905, *Heller 7961* (M); Sisson, 24 July–10 Aug., 1894, *Jepson 55m* (Calif.); Castle Crag, near Mt. Shasta, 23 June, 1893, *Dudley* (Stanford); McCloud River, 6 miles below Bartlett, June–Aug., 1893, *M. S. Baker* (M and Calif.); wet ground near Hyampam, Trinity Co., June, 1883, *Rattan* (Stanford); base of Mt. Eddy, Siskiyou Co., 20 June, 1919, *Heller 13261* (Cornell and M); Bear Valley, Nevada Co., 21 July, 1898, *Jepson 57m* (Calif.); near Clear Creek, Butte Co., 175 ft. alt., 1–15 May, 1897, *Brown 322* (M, R. Mt., and Stanford); near Cohasset, Butte Co., 12 April, 1915, *Heller 11805* (Cornell, M, and Stanford); Indian Valley, 1873, *Ames 21* (G, TYPE); without locality, *Bridges 200* (U. S.); Haile Place, Mariposa Co., 18 June, 1892, *Congdon C71* (G); La Jota Plateau, Howell Mt., 8 May, 1893, *Jepson 58m* (Calif.).

The petioled leaves, cylindrical calyx, and longer corolla separate this species from *M. latidens*, while the smaller corolla and glabrous style distinguish it from *M. washingtonensis* to which it is most nearly related.

41. **M. washingtonensis** Gdgr. in Bull. Soc. Bot. Fr. IV. **19**: 218. 1919.

M. peduncularis Gray, Syn. Fl. N. Am. ed. 2, **2**[1]: Suppl. 450. 1886, not Dougl.; Greene in Bull. Calif. Acad. Sci. **1**: 281. 1885; Howell, Fl. Northwest Am. 521. 1901; Piper, Fl. Southeast Wash. and Adj. Idaho, 228. 1914; Henry, Fl. Brit. Columbia, 269. 1915; Rydb. Fl. Rocky Mountains, 779. 1917.

A small pubescent or glandular-pubescent annual; stems somewhat quadrangular, 4–18 cm. high, simple or usually loosely branched from the base; leaves triangular-ovate or lanceolate, .9–1.5 cm. long, 2–7 mm. broad, rather thick, acute, denticulate, base more or less cuneate, often reddish-purple on the lower surface and with scattered white hairs, 1–3-veined from the base; petioles mostly shorter than the blades; pedicels filiform, much elongated, spreading or divaricate in fruit, slightly thickened at the base; calyx 5–7 mm. long, prismatic, minutely puberulent, distinctly angled, not inflated when mature, ribs reddish, teeth equal, short, broad, mucronate, 1 mm. long, ciliate; corolla bilabiate, 1–2 cm. long, yellow, tube slender, funnelform, much exserted, palate densely hairy, partly closing the throat, lobes rounded, entire, the lower lip spreading and almost twice as long as the erect upper one; stamens included, glabrous; style pubescent, not much longer than the upper pair of stamens, stigma-lips unequal, broadly rounded, laciniate; capsule not much over half as long as the calyx, oblong, placentae not separating; seeds oblong, smooth.

Distribution: moist sandy places in Washington and Oregon.

Specimens examined:

Washington: moist sandy banks of the Columbia River, W. Klickitat Co., Sept., 1883, *Suksdorf 204* (G); low sandy banks of the Columbia River, Klickitat Co., 25 Sept., 1881, *Suksdorf 51* (G); low sandy banks of the Columbia, W. Klickitat Co., Oct., Nov., 1885, *Suksdorf 560* (G, M, and Stanford, *type collection*); on banks of the Columbia River, 1884, *Barrett* (G).

Oregon: John Day Valley, 18 May, 1885, *Howell 519* (G and Phil.).

This species was confused by Dr. Gray, Dr. Greene, and a number of later botanists with *M. peduncularis* Benth. Material for comparison was sent to the Royal Botanic Gardens, Kew, England, and a sketch of the type specimen and a scrap from it were sent from there to the Missouri Botanical Garden. These show, without doubt, that Bentham's *M. peduncularis* is a small-sized plant of *M. floribundus*, and what Dr. Gray, Dr. Greene and others took for *M. peduncularis* is a plant that was not described until 1909, when Gandgoger published *M. washingtonensis* as a new species.

42. **M. ampliatus** Grant[1]

Stems erect or ascending, 7–15 cm. high, viscid-puberulent; leaves broadly ovate, acute, 1–2.5 cm. long, .5–1.2 cm. wide, dentate, base cuneate, petioles slender and mostly longer than the blade; pedicels filiform, somewhat spreading, longer than the leaves; calyx tubular, 5–6 mm. long, the fruiting calyx 6–7 mm. long, 3–4 mm. wide, teeth short, broadly triangular, acute, 1 mm. long, ciliate; corolla bilabiate, funnelform, 1.2–2 cm. long, yellow, tube exserted, throat ventricose, ampliate, lobes short, unequal, the lower lip longer and little spreading; stamens included, glabrous; style barely exserted, glabrous, stigma-lips equal; capsule shorter than the calyx, narrowly ovate, acute, placentae adherent at the apex; seeds longitudinally wrinkled.

Distribution: moist places in southwestern Idaho and eastern Washington.

Specimens examined:

Idaho: Lake Waha, Nez Perces Co., 2500–3000 ft. alt., 27 June, 1896, *Heller & Heller 3330* (M, TYPE, Cornell, U. S., and Stanford); moist places on hillsides, Wessell Place near Lewiston, 19 June, 1894, *Henderson 2676* (G and R. Mt.); Lake Waha,

[1] **Mimulus ampliatus** Grant, sp. nov., caules erecti, viscido-puberulentes, 7–15 cm. longi; foliis late ovatis, dentatis, basi cuneatis, petiolo lamina longiore; calyce cylindrato, dentibus late triangularibus-acutis; corolla flava, 1.2–2.2 cm. longa, fauce ampliata, lobis inaequalibus, brevibus; stylo glabro, laciniis aequalibus.—Collected about Lake Waha, Nez Perces Co., Idaho, 2000–3500 ft. alt., 27 June, 1896, *A. A. & E. Gertrude Heller 3330* (Mo. Bot. Gard. Herb. no. 893244, TYPE).

Crag's Mts., 23 June, 1894, *Henderson 2675* (G); on hills, Lake Waha, Nez Perces Co., 23 June, 1890, *Henderson 2675a* (Cornell).

Washington: along irrigation ditches, Wawawai, May, 1897, *Elmer 752* (M, R. Mt., and Pomona).

43. **M. arenarius** Grant[1] Pl. 8, fig. 1.

Small glandular-pubescent annuals, somewhat slimy and with soft white hairs; stems 8–15 cm. long, simple or branched; leaves few, mostly elliptical, sometimes ovate, with a rounded base, acute, 1–1.7 cm. long, 3–7 mm. wide, sessile, often reddish on the lower surface, entire or sparingly denticulate, 1–3-nerved from the base, occasionally with short-petioled lower leaves; fruiting pedicels slender, reddish, longer than the leaves, usually divaricate and more or less curved; calyx narrowly campanulate, 5–6 mm. long, slightly larger in fruit, 6–8 mm. long, often dotted with red, teeth subequal, triangular-acute, ciliate; corolla bilabiate, 1.3–1.7 cm. long, yellow, tube exserted, throat funnelform, with a hairy ring at the base of the lobes and two densely hairy ridges more or less dotted with red down the throat, lobes unequal, the middle lobe of the lower lip longer and spreading; stamens glabrous, included, filaments flat; style slightly exserted, flattened, glabrous, stigma-lips broadly rounded, equal; capsule elliptical, longitudinally striate; seeds oval, papillate.

Distribution: moist sandy places in the Transition Zone of the Sierra Nevada Mts., from Mariposa Co. to Fresno Co., California.

Specimens examined:

California: near Wawona, Mariposa Co., 5000 ft. alt., 23 June, 1918, *A. L. Grant 1309* (N. Y., Cornell, M, Calif. Acad., and Calif.); in sandy places, Jackass Meadow, Madera Co., 7000 ft. alt., 25 June, 1918, *A. L. Grant 1336* (Cornell, M, and Calif.);

[1] **Mimulus arenarius** Grant, sp. nov., annuus pumilus, pubescens, viscoso-villosus; foliis ellipticis, integerrimis vel parce denticulatis; pediculis foliis longioribus, plerumque divaricatis, curvatis; calyce fructifero campanulato, 6–8 mm. longo, dentibus subaequalibus; corollae labiis inaequalibus, 1.3–1.7 cm. longis; stylo exserto, glabro, laciniis aequalibus.—Collected in moist sandy places near Huntington Lake, Fresno Co., 7000 ft. alt., 5 July, 1917, *Adele Lewis Grant 1032* (Gray Herb., Phil. Acad. Nat. Sci. Herb., Cornell Univ. Herb., Mo. Bot. Gard. Herb. no. 849663, TYPE, Rocky Mt. Herb., Univ. Calif. Herb., Stanford Univ Herb., and Pomona Coll. Herb.).

Arnold Meadow, Madera Co., 5000 ft. alt., 27 June, 1918, *A. L. Grant 1344a* (Cornell, M, and Calif.); Raymond, Madera Co., 10 June, 1894, *Burnham* (Cornell); Huntington Lake, Fresno Co., 6 July, 1918, *A. L. Grant 1412* (M and Calif.); Huntington Lake, 20 July, 1917, *A. L. Grant 1119* (M and Stanford); in moist sandy places near the Lake, Huntington Lake, 7000 ft. alt., 5 July, 1917, *A. L. Grant 1032* (G, Phil., Cornell, M, TYPE, R. Mt., Calif., Stanford, and Pomona).

This species is intermediate between *M. floribundus* and *M. Pulsiferae.* It may be separated from the first by its leaves, which are mostly elliptical and either entire or sparingly denticulate, by the length of the corolla, and by the curved and divaricate pedicels. It may be distinguished from *M. Pulsiferae* by the type of the pubescence, the shorter calyx-tube, and the longer style.

44. **M. floribundus** Dougl. in Lindl. Bot. Reg. *pl. 1125.* 1828; Benth. Scroph. Ind. 29. 1835; DC. Prodr. **10:** 372. 1846; Hook. Fl. Bor. Am. **2:** 99. 1840; Hook. & Arn. Bot. Beechey's Voyage, 378. 1840; Gray in Proc. Am. Acad. **11:** 99. 1876; Bot. Calif. **1:** 569. 1876; Syn. Fl. N. Am. 2^1: 278. 1878, ed. 2, and Suppl. 450. 1886; Wats. Bot. King's Exp. 224. 1871; Greene in Bull. Calif. Acad. Sci. **1:** 117. 1885; Manual Bay Region, 276. 1894; Howell, Fl. Northwest Am. 522. 1901; Jepson, Fl. W. Mid. Calif. 407. 1901, and ed. 2, 379. 1911; Eastwood, Fl. South Fork King's River, Sierra Club Publ. 27: 66. 1902; Abrams, Fl. Los Angeles, 366. 1904, and ed. 2, 336. 1917; Nelson in Coulter & Nelson, Manual Cent. Rocky Mountains, 454. 1909; Hall, Yosemite Fl. 222. 1912; Piper, Fl. Southeast Wash. and Adj. Idaho, 228. 1914; Henry, Fl. Brit. Columbia, 269. 1915; Rydb. Fl. Rocky Mountains, 779. 1917.

M. peduncularis Dougl. in Benth. Scroph. Ind. 29. 1835; G. Don, Hist. Dichlam. Pl. **4:** 554. 1838; Walp. Rep. **3:** 376. 1844–45.

M. serotinus Suksd. Deut. Bot. Monatsschr. **18:** 154. 1900.

M. floribundus β *minor* Hook. Fl. Bor. Am. **2:** 99. 1840.

M. pubescens Benth. in DC. Prodr. **10:** 372. 1846.

M. deltoideus Gdgr. in Bull. Soc. Bot. Fr. **19:** 218. 1919.

A viscid-villous, more or less slimy annual; stems 8–50 cm. long, diffusely branched from the base, somewhat weak, often climbing over moist rocks; leaves scattered, thin, ovate to ovate-lanceolate, 1.5–5 cm. long, .5–3 cm. wide, acute, dentate with short salient teeth, ciliate, base broad, mostly truncate or subcordate, 3–5-nerved, usually shorter than the internodes, petioles longer or shorter than the blade, sometimes slightly winged or occasionally sessile; pedicels filiform, frequently shorter than the leaves and more or less spreading in maturity; calyx plicate-carinate, slightly campanulate, 4–7 mm. long, broadly ovate in fruit and 6–10 mm. long, often spotted or tinged with red, teeth triangular, lanceolate, 1–1.5 mm. long, ciliate, equal; corolla cylindrical to funnelform, .7–1.4 cm. long, yellow, tube slightly exserted, throat short, ampliate, dotted or streaked with red, lobes unequal, mostly erect, short, rounded, the lower lip sometimes slightly spreading; style and stamens glabrous, included, stigma-lips equal, rounded; capsule chartaceous, shorter than the calyx, oblong, placentae completely adherent; seeds oval, longitudinally wrinkled.

Distribution: moist places in the mountains from British Columbia south to Colorado and California.

Specimens examined:

British Columbia: Sprout, 30 June, 1890, *Macoun* (M); grassy places, Elk River, 24 July, 1883, *Dawson* (G).

Wyoming: wet banks, Halleck Cañon, Albany Co., 4 July, 1900, *Nelson 7440* (G, M, R. Mt., and Pomona); moist ledges, Jelm, Albany Co., 8 July, 1907, *Nelson 9076* (R. Mt.); Grand Teton, Jackson's Hole, 6 Aug., 1920, *Payson & Payson 2226* (Cornell and R. Mt.).

Colorado: Black Cañon, Gunnison Watershed, 7075 ft. alt., 20 June, 1901, *C. F. Baker 200* (M, R. Mt., and Pomona); Cimarron, 6900 ft. alt., 6 June, 1901, *C. F. Baker 30* (G, M, and Pomona); Arkansas Cañon, 21 July, 1873, *T. S. Brandegee 815* (M); Colorado, 1872, *Greene 224* (M); Fort Collins, 28 Aug., 1894, *C. F. Baker 554* (Pomona); San Luis Valley, Sept., 1873, *Wolfe 311* (Cornell); pond, Boulder, 5500 ft. alt., 30 June, 1906, *Daniels 247* (M); mountains between Sunshine and Ward, Boulder Co., 8000 ft. alt., Aug., 1902, *Tweedy 5202* (R. Mt.);

Powell's Colorado Exploring Expedition, 1868, *Vasey 396* (M).

Arizona: Verde River, 27 May, 1867, *Smart 203* (G).

Idaho: sandy places, Lemp Gulch, Boise, 22 Aug., 1911, *Clark 289* (R. Mt.); Truckee Valley, 4500 ft. alt., July, 1867, *Watson 794* (G); Salmon, 23 June, 1920, *Payson & Payson 1755* (Cornell and R. Mt.).

Nevada: about Washoe Lake, Washoe Co., 25 June, 1902, *C. F. Baker 1174* (M, R. Mt., and Pomona).

Washington: on the Columbia, 1826, *Douglas* (M, sketch of the type of *M. pedunculāris* Benth. sent from Kew Herb.); damp sandy bank of the Columbia River, Bingen, Sept.–Dec., 1904, *Suksdorf* (R. Mt.); damp, sandy banks of the Columbia River, Sept.–Dec., 1892, *Suksdorf 2185* (M and Stanford); damp cliffs, Almata, 28 June, 1894, *Piper 1867* (R. Mt. and Pomona); Sprague, 30 May, 1892, *Henderson* (M); Whitman Co., 18 July, 1892, *Henderson* (M); springy patches or along irrigation ditches, Wawawai, May, 1897, *Elmer 754* (M); Yakima Region, Northern Transcontinental Survey, 1882, *T. S. Brandegee 206a* (M); Spokane Falls, 24 Sept., 1880, *Watson 309* (G); moist ground, Spokane, 18 Aug., 1892, *Sandberg, MacDougal & Heller 926* (G); moist sandy bank of the Columbia, W. Klickitat Co., Sept., 1883, *Suksdorf 205* (G); on limestone rocks on dry sandy soils in the interior of the Columbia, 1826, *Douglas* (G, probably part of the *type collection*).

Oregon: Currant Creek, 11 May, 1885, *Howell 517* (G); moist situations, North Pine Creek, near Snake River, 13 July, 1899, *Cusick 2237* (Cornell and M); Oregon, 1871, *E. Hall 377* (G and M).

California: near Kneeland, Humboldt Co., June, 1882, *Rattan* (Stanford); moist places in a forest near Little Lake, Mendocino Co., June, 1882, *Rattan* (G); swamp near Willett's, Mendocino Co., June, 1882, *Rattan* (Stanford); Squaw Creek Ranger Station, Shasta Co., June, 1916, *Drew* (Stanford); Stillwater, Shasta Co., 4 July, 1898, *M. S. Baker 280* (Pomona); Eldorado Co., 1886, *Rattan* (Stanford); Sulphur Creek, Colusa Co., 26 June, 1877, *Rattan* (Stanford); Sierra Co., 1874, *Lemmon* (G); Sonoma Creek bed, 9 May, 1885, *Rattan* (Stanford); Swanton, Santa Cruz Co., spring, 1912, *Rich* (Stanford); Boulder Creek,

Santa Cruz Co., 3 Aug., 1907, *Walker 808* (Pomona); Santa Cruz, 24 June, 1903, *C. H. Thompson* (M); Carmel River near Pacific Grove, 5 July, 1907, *Patterson & Wiltz* (Stanford); Pine Mt. opposite St. Simeon Bay, San Luis Obispo Co., 22 July, 1876, *Edw. Palmer 323* (M); growing beside a water trough and climbing over the wet rocks, Priest's Grade, Tuolumne Co., 9 July, 1916, *A. L. Grant 823* (M, Ore., and Calif. Acad.); in meadows, Yosemite, 17 Aug., 1872, *Redfield 6107* (M); near Stoneman Orchard, Yosemite Valley, 4000–4500 ft. alt., 19 June, 1911, *Abrams 4380* (Stanford); meadow near Sentinel Hotel, Yosemite Valley, 4000–4500 ft. alt., 6 July, 1911, *Abrams 4627* (Stanford); Arnold Meadow, Madera Co., 5000 ft. alt., 27 June, 1918, *A. L. Grant 1344* (G, N. Y., M, Calif., and Pomona); Huntington Lake, Fresno Co., 7000 ft. alt., 26 July, 1917, *A. L. Grant 1469* (M); near Milo, Tulare Co., 6 April, 1900, *Dudley* (Stanford); wet rocks, Middle Tule River, 4000–5000 ft. alt., Apr.–Sept., 1897, *Purpus 5602* (M); Three Rivers, Tulare Co., 9 July, 1904, *Culbertson*, distributed as *C. F. Baker 4214* (M); Kern River Cañon, near Bakersfield, 7 Oct., 1910, *McGregor 32* (Stanford); Avalon, Santa Catalina Island, April, 1896, *Trask* (M); in wet arroyos, San Clemente Island, June, 1903, *Trask* (U. S.); Upper Millard's Cañon, San Gabriel Mts., 29 July, 1917, *F. Grinnell, Jr.* (Stanford); Sturtevant's Camp, Mt. Wilson, 25 July, 1901, *G. B. Grant 4452* (Stanford); weakly erect in shady places near water, Millard Canyon, Pasadena, 17 June, 1904, *G. B. Grant 790* (R. Mt. and Stanford); West Fork San Gabriel River, Los Angeles Co., 9 July, 1901, *Abrams 1873* (Stanford); along streams, near Laguna, July, 1916, *Crawford* (Pomona); moist, sandy creek-bank near Los Angeles, 25 June, 1915, *Macbride & Payson 765* (R. Mt.); sandy flats along creeks, Santa Monica Range, June, 1890, *Hasse* (M); along streams in Palmer's Cañon, Claremont, 14 Aug., 1915, *Crawford* (M and Pomona); Icehouse Cañon, San Antonio Mts., 5200 ft. alt., 16 June, 1918, *I. M. Johnston* (Pomona); San Antonio Cañon near Claremont, 2 Aug., 1903, *C. F. Baker 3448* (M and Pomona); Little Santa Anita Canyon, Los Angeles Co., 1 July, 1902, *Abrams 2611* (M and Stanford); Red Hill near Upland, 1300 ft. alt., 4 July, 1918, *I. M. Johnston*

(Pomona); wet sand in wash, Upland, 4 May, 1917, *Parish 11172* (M); river banks, Victorville, 26 June, 1915, *Parish 10606* (Stanford); Little Bear Valley, San Bernardino Mts., Aug., 1884, *Parish 447* (Stanford); Arrowhead Hot Springs, 23 May, 1906, *G. B. Grant 6658* (Stanford); Icehouse Cañon, San Antonio Mts., 7000 ft. alt., 16 June, 1918, *Parish 11961* (M); shady places in the mts., San Bernardino Co., May, 1888, *Parish* (M); Strawberry Valley, Riverside Co., 8 Aug., 1901, *G. B. Grant 4488* (Stanford); along water courses, in the vicinity of Strawberry Valley, 5200 ft. alt., June, 1901, *H. M. Hall 2202* (M and Stanford); river bottoms by stream in very damp soil, San Jacinto River Cañon, 30 May, 1917, *Jenkins & Street* (Pomona); Cuyamaca Mts., July, 1889, *Orcutt* (M); Pine Valley, San Diego Co., 2 Sept., 1882, *Orcutt 591* (M); Jamul Valley, San Diego Co., 1500 ft. alt., June, 1895, *Stokes* (Stanford).

Mexico:

Sinaloa: gravel beds along river in vicinity of San Blas, 24 March, 1910, *Rose, Standley & Russell 13395* (U. S.).

Chihuahua: Hacienda, San Jose, 2000 ft. alt., Aug., 1885, *Edw. Palmer 62* (Phil.).

44a. Var. geniculatus (Greene) Grant, comb. nov.

M. geniculatus Greene in Bull. Calif. Acad. Sci. **1**: 280. 1885; Hall, Yosemite Fl. 222. 1912.

Branches spreading, typically strongly geniculate at the thickened nodes, plant sparingly villous.

Distribution: in the mountains of Idaho and California.

Specimens examined:

Idaho: dry, stony cliffs, Three Creeks, 1 July, 1912, *Nelson & Macbride 2235* (R. Mt.).

California: Truckee, Sept., 1888, *Brandegee* (G); Truckee, Sept., 1888, *Curran* (Calif.); Lewis, Mariposa Co., 26 April, 1895, *Congdon* (Stanford); Fresno Co., Oct., 1890, *Peckinpah* (U. S.); Toll House, Fresno Co., 2050 ft. alt., 13 June, 1900, *Hall & Chandler 5* (Stanford); in rock crevices of Dry Butte, Tehachapi, 14 June, 1907, *Hasse & Davidson*, (G); Tehachapi, 1884, *Curran* (M and Stanford, *type collection*); in moist sandy

places along streams, San Bernardino Forest Reserve, 28 Dec., 1903, *Mell & Knopf* (M); Caliente, 11 May, 1891, *T. S. Brandegee* (Calif.).

Numerous specimens of *M. floribundus* occur which show slight geniculations at some of the nodes and connect the variety with the species.

44b. Var. **membranaceus** (A. Nels.) Grant, comb. nov.

M. membranaceus A. Nels. in Bot. Gaz. **34**: 30. 1902; Rydb. Fl. Rocky Mountains, 779. 1917.

Stems slender, more or less procumbent, sparsely villous, geniculate, sometimes winged on the upper part; leaves thin, membranaceous, often almost glabrous, the petioles frequently winged.

Distribution: in damp, shaded places in Rocky Mountains and in California.

Specimens examined:

Montana: McDonald Lake, 7 Aug., 1893, *Williams 343* (R. Mt.).

Wyoming: under moist cliffs, Crow Creek, Albany Co., July, 1903, *Nelson 8951* (G, M, and R. Mt.); Cummins, 28 July, 1895, *Nelson 1515* (Cornell, M, and R. Mt.); headwaters of Clear Creek and Crazy Woman River, Big Horn Mts., 7000–9000 ft. alt., 20 July–15 Aug., *Tweedy 3423* (R. Mt.); in damp, shaded woods, Centennial, Albany Co., 27 July, 1900, *Nelson 7729* (R. Mt.); Centennial Hills, 17 Aug., 1895, *Nelson 1683* (G, Cornell, M, and R. Mt., TYPE); Centennial, Albany Co., 7 Aug., 1902, *Nelson 8828* (G, Cornell, M, R. Mt., and Pomona).

Colorado: Flagstaff Mt., near Boulder, 19 July, 1906, *Robbins 2138* (R. Mt.); in wet places, mountain sides about Empire, 6 Aug., 1892, *Patterson 251* (M); wet rocks, Georgetown, 17 Aug., 1874, *Engelmann* (M).

Idaho: shaded river banks, St. Anthony, 5 July, 1901, *Merrill & Wilcox 827* (R. Mt.).

Utah: Bullion Cañon, in and near the Gorge, 27 July, 1905, *Rydberg & Carlton 7269* (R. Mt.).

California: hills about 3 miles above Pollasky, 11 April, 1906, *Heller 8142* (Phil., M, and Stanford); Millard Canyon, near

Pasadena, 16 June, 1904, *G. B. Grant 790a* (R. Mt. and Stanford); San Bernardino Valley, 1000 ft. alt., 28 June, 1905, *Parish 5405* (R. Mt.).

This is undoubtedly a shade form of the species and is to be distinguished by its thin leaves, which are sparsely villous, and by its usually winged petioles. All gradations are found between this and the species.

44c. Var. **subulatus** Grant, var. nov.[1]

Fruiting calyx 8–9 mm. long, constricted at the throat, teeth deltoid-subulate, 2–3 mm. long, and strongly spreading; corolla 1.5–2 cm. long, broadly funnelform.

Distribution: in damp sandy soil of the central Sierra Nevada Mountains, California.

Specimens examined:

California: Yankee Hill, Columbia, 8 June, 1915, *Jepson 6401* (Calif.); growing in moist places along the roadside, between Hog Ranch and Hetch-Hetchy Valley, 4200 ft. alt., 16 June, 1917, *A. L. Grant 970* (M, TYPE, G, U. S., Calif.); near Hetch-Hetchy Valley, 10 June, 1916, *A. L. Grant 805* (M and Calif.); McGill's Meadow to Lake Eleanor, Tuolumne Co., 12 July, 1894, *Burnham* (Cornell); above Mormon Bar, Mariposa Co., 26 July, 1903, *Congdon* (M); Coulterville Trail, Mariposa Co., 29–30 July, 1895, *Congdon* (Stanford); Hetch-Hetchy, 3700 ft. alt., 29 July, 1909, *Jepson 3442* (Calif.); Hog Ranch, Yosemite Park, 5000 ft. alt., 3 Aug., 1911, *Jepson 4627* (Calif.); Coulterville, 14 July, 1896, *Jepson 38m* (Calif.); Little Yosemite, 6300 ft. alt., 5 July, 1909, *Jepson 3143* (Calif.).

45. **M. jungermannioides** Suksd. Deut. Bot. Monatsschr. **18**: 154. 1900; Piper, Contr. U. S. Nat. Herb. **11**: 511. 1906.

A low, nearly prostrate perennial, propagating itself by runners which produce small terminal buds in the fall; stems 5–30 cm.

[1] Mimulus floribundus Dougl. var. subulatus Grant, var. nov., calyx fructifer 8–9 mm. longus; fauce constricto, dentibus triangulari-subulatis, 2–3 mm. longis, patulis; corolla 1.5–2 cm. longa.—Collected in moist places along the roadside, between Hog Ranch and Hetch-Hetchy Valley, 4200 ft. alt., 16 June, 1917, *Adele Lewis Grant 970* (Gray Herb., U. S. Nat. Herb., Mo. Bot. Gard. Herb. no. 849666, TYPE, and Univ. Calif. Herb.).

long, the whole plant densely viscid-villous; leaves numerous, thin, broadly ovate, acute, 1.5–2 cm. long, 1.2–1.5 cm. wide, base cuneate, cordate, or broadly triangular, petioles shorter than the blade, irregularly denticulate; pedicels filiform, much longer than the leaves; calyx campanulate, acutely angled, little or not at all inflated in fruit, 7–8 mm. long, teeth short, broadly triangular, 1–1.5 mm. long, mucronate or often 2–3-cleft, subequal, ciliate; corolla funnelform, bilabiate, 16–18 mm. long, yellow, tube slender, twice as long as the calyx, throat and lobes short; stamens included; stigma-lips equal; capsule lanceolate, shorter than the calyx, stipitate, placentae adherent to the apex; seeds oval, minutely papillate.

Distribution: in damp places in Washington and Oregon. Rarely collected.

Specimens examined:

Washington: on steep, overhanging, damp cliffs near Bingen, 11 Aug.–Nov., 1892, *Suksdorf 1470* (N. Y., F., and M, *type collection*).

Oregon: Rainier, 1893, *Briggs* (Phil.).

46. M. moschatus Dougl. in Lindl. Bot. Reg. *pl. 1118.* 1828; Benth. Scroph. Ind. 29. 1835; DC. Prodr. **10**: 372. 1846, in part; Hook. Fl. Bor. Am. **2**: 99. 1840; Gray in Bot. Calif. **1**: 569. 1876, in part; Syn. Fl. N. Am. **2**^{1}: 27. 1878, ed. 2, and Suppl. 447. 1886; Greene in Bull. Calif. Acad. Sci. **1**: 118. 1885; Manual Bay Region, 276. 1894; Conzatti & Smith, Fl. Sin. Mex. 117. 1897; Howell, Fl. Northwest Am. 522. 1901; Eastwood, Fl. South Fork King's River, Sierra Club Publ. 27: 65. 1902; Abrams, Fl. Los Angeles, 365. 1904, and ed. 2, 336. 1917; Piper, Contr. U. S. Nat. Herb. **11**: 509. 1906, in part; Fl. Southeast Wash. and Adj. Idaho, 228. 1914, in part; Nelson in Coulter & Nelson, Manual Cent. Rocky Mountains, 454. 1909, in part; Henry, Fl. Brit. Columbia, 268. 1915; Rydb. Fl. Rocky Mountains, 779. 1917.

A more or less slimy, viscid-villous perennial; rootstocks slender, often moniliform, stems 5–30 cm. long, creeping or decumbent, rooting at the lower nodes; leaves ovate, 1–4 cm. long, .5–2 cm. wide, acute or obtuse, entire or sparingly denticulate, base sometimes subcordate or nearly truncate, short-

petioled, pinnately-veined; flowers few, pedicels slender, shorter than the leaves; calyx campanulate, 8–10 mm. long, teeth lanceolate, acute or often subulate, unequal, frequently nearly one-third the length of the tube; corolla funnelform, 1.4–2 cm. long, yellow, tube cylindrical, exserted, throat short, usually striped with red and with two densely bearded lines below the lower lip, lobes rounded, subequal; stamens included, filaments glabrous, anthers pubescent, coherent nearly to the base; style glabrous, stigma-lips broad, rounded, equal, fimbriate; capsule ovate, acuminate, included, placentae adherent to the apex; seeds oval, tuberculate.

Distribution: moist places in mountain regions from Montana and British Columbia to southern California. It has become established in various parts of Europe and eastern North America.

Specimens examined:

Montana: Helena, Aug., 1892, *Starz* (M); Coeur D'Alene, near Borax, 6000 ft. alt., 8 Aug., 1902, *Blankinship* (M); Summit, Great Northern Ry., 25 July, 1894, *Williams* (R. Mt.).

Wyoming: East de Lacy's Creek, Yellowstone Park, 10 Aug., 1897, *Rydberg & Bessey 4942* (R. Mt.); Yellowstone Park, 5 Aug., 1885, *Letterman* (M).

Idaho: Lake Waha, Nez Perces Co., 3500–4000 ft. alt., 25 June, 1896, *Heller & Heller 3315* (M and Cornell); about Lake Coeur d'Alene, June–July, 1892, *Aiton* (M); Forks of St. Mary's River, Coeur d'Alene Mts., 4 July, 1895, *Leiberg 1168* (M); wet sunny ground, along creeks, Cedar Mts., near Moscow, 7 July, 1894, *Henderson* (Cornell and R. Mt.); Cedar Mts., June, 1896, *Elmer 8074* (Pomona); Bald Knob, Cedar Mt., Latah Co., 20 June, 1892, *Sandberg, McDougal & Heller 444* (Stanford); moist sand, Silver City, Owyhee Co., 7000 ft. alt., 18 July, 1910, *Macbride 421* (M and R. Mt.); Trinity, Elmore Co., 9 Aug., 1910, *Macbride 569* (M and R. Mt.); Tamarack, Washington Co., 11 Aug., 1911, *Clark 230* (M and R. Mt.); shady stream bottoms, Boise, 2880 ft. alt., 18 June, 1910, *Macbride 261* (R. Mt.); Boise Basin, July, 1892, *Mulford* (M); river banks, Kootenai Co., July, 1891, *Leiberg 383* (Pomona).

Utah: vicinity of Clayton Peak, Wasatch Mts., 12–26 Aug., 1903, *Stokes* (M); Peterson, Weber River, 18–24 July, 1902,

Pammel & Blackwood 3784 (M); Big Cottonwood Cañon, below Silver Lake, 27 June, 1905, *Rydberg & Carlton 5354* (R. Mt.).

British Columbia: near mouth of Downie Creek, 9 Aug., 1905, *Shaw 1119* (M); deep thicket, east of Nelson, 15 June, 1905, *Shaw 662* (M); Kootenai River, 1 July, 1890, *Macoun* (M); Skagit River, 5 July, 1905, *Macoun 76789* (M and Cornell); Illecillewaet Valley, Loop Trail, Glacier, 3500–4000 ft. alt., 20 July, 1906, *S. Brown 662* (M); river bottoms, Vancouver Island, 7 Aug., 1902, *Rosendahl 895*, in part (Stanford); margins of grassy springs near Fort Vancouver, 1825, *Douglas* (G).

Washington: Lookout Mt., Whatcom Co., 23 Aug., 1914, *Muenscher 964* (Cornell); Stevens Pass, Cascade Mt., 3950 ft. alt., 16 Aug., 1893, *Sandberg & Leiberg 362* (M); Tacoma, 16 July, 1880, *Engelmann* (M); Mt. Constitution, San Juan Islands, 25 June–1 Aug., 1917, *Zeller & Zeller 12021* (M); Newman Lake, 14 Aug., 1912 *Turesson 28* (M); Kalama, 27 July, 1918, *Roush 2, 3* (Cornell and M); near Montesano, Chehalis Co., 9 July, 1917, *J. M. Grant* (Cornell); swamps, Sequim, Aug., 1915, *J. M. Grant* (M).

Oregon: stream banks in mountains of Lake Co., 21 Aug., 1901, *Cusick 2773* (M, Cornell, and R. Mt.); wet granitic soil, Wallowa Mts., Aug., 1906, *Cusick 3116* (M and Stanford); Portland, 5 July, 1903, *Lunell* (R. Mt.); near Portland, 1 Aug., 1880, *Engelmann* (M); Sullivan's Gulch, Portland, 14 July, 1902, *Sheldon S10880* (M); Cottonwood Creek Cañon, 1325 ft. alt., 3 June, 1897, *Sheldon 8242* (M); Big Cañon, Wallowa Co. 24 Aug., 1897, *Sheldon 8773* (M); wet meadow, vicinity of Oregon City, 11 June, 1905, *Lyon 58* (Stanford); Deer Creek Valley, Josephine Co., 4–16 July, 1919, *Dale* (Stanford); Calapooya Valley, 18 July, 1899, *Barber* (R. Mt.); Queen's Branch, Jackson Co., 25 June, 1892, *Hammond 312* (M); near Canyonville, Aug., 1922, *Epling 5378* (Epling); Crater Lake National Park, 20 July, 1918, *Heller 13060* (M).

California: Mt. Bidwell, Modoc Co., 7 Aug., 1918, *Jepson 7855* (Calif.); in the "Horse pasture" near the summit of Mt. Sanhedrin, Lake Co., 20 July, 1902, *Heller 5923* (Cornell, M,

R. Mt., and Pomona); Cosumnes, Eldorado Co., 28 Aug., 1896, *Hansen 1908* (Stanford); Yosemite Valley, 4–12 July, 1901, *G. B. Grant 4245* (Stanford); Mariposa, 30 April, 1895, *Congdon* (Stanford); Crane Flat, Yosemite, 15 Aug., 1872, *Redfield 6121a* (M); Yosemite Falls, 5300 ft. alt., 25 June, 1911, *Jepson 4272* (Calif.).

This plant is commonly cultivated in American and European gardens. The musk-like odor is very characteristic and varies in intensity with the time of the day and with the individual plants, some appearing to be scentless at one time and fragrant at another. The moniliform rootstocks, the main character on which Dr. Greene based *M. moniliformis*, are found on specimens of typical *M. moschatus*.

46a. Var. **longiflorus** Gray, Syn. Fl. N. Am. 2¹: 278. 1878, ed. 2, and Suppl. 447. 1886; Curran in Proc. Calif. Acad. Sci. II. **1**: 263. 1888; Hall, Yosemite Fl. 221. 1912. Pl. 9, fig. 3.

M. moschatus Maund, Bot. **3**: 283, *pl. 71.* 1829–30, not Douglas.

M. dentatus var. *gracilis* Gray in Bot. Gaz. **7**: 112. 1882.

M. moniliformis Greene in Bull. Calif. Acad. Sci. **1**: 10. 1884, and 119. 1885; Gray, Syn. Fl. N. Am. ed. 2, 2¹: Suppl. 447. 1886; Eastwood, Fl. South Fork King's River, Sierra Club Publ. 27: 65. 1902; Hall, Yosemite Fl. 222. 1912; Smiley in Univ. Calif. Publ. Bot. **9**: 334. 1921.

M. moschatus var. *pallidiflorus* Suksd. Deut. Bot. Monatsschr. **18**: 154. 1900.

Rootstocks often moniliform; stems more nearly erect, commonly viscid-villous, occasionally nearly glabrous; calyx 8–11 mm. long, teeth nearly equal and shorter than in the species; corolla 2–3 cm. long, the tube twice as long as the calyx.

Distribution: wet places in the mountains from British Columbia to California. This is the common form in California.

Specimens examined:

British Columbia: Chilliwack Valley, 3000 ft. alt., 26 July, 1901, *Macoun 54474* (M); Kootenai River, 1 July, 1890, *Macoun* (G and M); Port Alberni, Vancouver Island, 27 June, 1916, *Henry 9054* (G).

Washington: springs near Chenowith, Skamania Co., 7 July, 1894, *Suksdorf 2320* (N. Y. and M); in wet peat-like swamps near Doubtful Lake near the summit of Cascade Pass, Sept., 1897, *Elmer 745* (M, R. Mt., and Pomona); springy places, W. Klickitat Co., 18 June, July, 1885, *Suksdorf* (M and Stanford).

California: Log Lake, Shackleford Creek, Siskiyou Co., 5 June, 1910, *Butler 1511* (M, R. Mt., and Stanford); damp soil, Shackleford Creek, 4000 ft. alt., 8 July, 1910, *Butler 1685* (R. Mt. and Stanford); near Shasta Springs, Siskiyou Co., 5 June, 1905, *Heller 7960* (M and Stanford); north side, Mt. Shasta, Siskiyou Co., 11–16 June, 1897, *H. E. Brown 405* (M and R. Mt.); Deetz Station, near Black Butte, 3800 ft. alt., 25 Aug., 1914, *Heller 11714* (Cornell, M, and Stanford); Klamath River near Requa, Del Norte Co., June, 1899, *Dudley* (Stanford); Forestdale, Modoc Co., July, 1898, *M. S. Baker 545* (Calif.); Coffee Creek, Salmon Mts., Trinity Co., July, 1909, *H. M. Hall 8555* (R. Mt.); Lassen's Peak, Aug., 1896, *Austin 395* (G and M); Pine Creek, Lassen Co., 9 July, 1894, *Baker & Nutting* (R. Mt.); Martin Springs, Lassen Co., 30 July, 1922, *Brown & Wieslander 17* (Cornell and Calif.); Squirrel Creek, vicinity of Quincy, Plumas Co., 29 June, 1919, *Wagner 300* (Stanford); near Lassen Buttes, Plumas Co., 6000 ft. alt., 15–31 Aug., 1897, *H. E. Brown 669* (M and R. Mt.); near the summit of Soapstone Ridge, Plumas Co., 7 July, 1915, *Heller 12064* (M and Stanford); Red Point, Placer Co., 4500 ft. alt., July, 1892, *Price* (Stanford); near Prattville at Clear Creek, 5000 ft. alt., 2 July, 1897, *Jones* (M); in coarse granitic sand, west of Emigrant Gap, Placer Co., 12 Aug., 1917, *Heller 12875* (M and Stanford); Cisco, 1870, *Kellogg & Branner* (G); Bear Valley, Nevada Co., 4500 ft. alt., 20 July, 1898, *Jepson 51m* (Calif.); Cahto to Westport, Mendocino Co., 30 July, 1897, *Jepson 42m* (Calif.); Soldier's Ridge, Mendocino Co., 24 July, 1897, *Jepson 45m* (Calif.); summit of Yuba Pass, July, 1913, *Ames 19* (Calif.); about Summit Station, Nevada Co., 20 July, 1903, *Heller 6973* (M, R. Mt., Stanford, and Pomona); lower end of Donner Lake, Nevada Co., 16 July, 1903, *Heller 6947* (M, Stanford, and Pomona); Nevada Co.,

1892, *Michener & Bioletti* (M); Sierra Valley, Sierra Co., without date, *Lemmon 72* (G and M); Little Chico Creek, Butte Co., March, 1896, *Austin 147* (M); Chico Meadows, Butte Co., 4000 ft. alt., 22 June, 1914, *Heller 11511* (Cornell, M, and Stanford); Coast Range west of Alder Springs, Glenn Co., 5300 ft. alt., 5 July, 1917, *Heller 12797* (M); near Echo Camp, Eldorado Co., 7000 ft. alt., 6 Aug., 1915, *Heller 12165* (Cornell, M, and Stanford); Summit, Aug., 1883, *Greene* (M and G); Donner Lake, Nevada Co., July, 1891, *Sonne 268* (M); Glen Alpine, Eldorado Co., 12 July, 1898, *Price* (Stanford); Lake Tahoe, 1 Aug., 1891, *Evans* (M); Bear River, Amador Co., 5500 ft. alt., 30 July, 1896, *Hansen 1951* (M); Doak's Ridge, Amador Co., 4000 ft. alt., July, 1892, *Hansen 465* (M and Stanford); Snowdon Ranch, Calaveras Co., 7 Aug., 1890, *Jepson 46m* (Calif.); Strawberry, Tuolumne Co., 16 July, 1915, *A. L. Grant 55* (Cornell); banks of Tuolumne River, Big Oak Flat Road, Tuolumne Co., 24 July, 1918, *Ferris 1458* (Stanford); Crocker's, Tuolumne Co., 3 Aug., 1911, *Jepson 4640* (Calif.); Brightman's Flat, Tuolumne Co., 3 Aug., 1916, *A. L. Grant 892* (Cornell and Stanford); Hog Ranch, above Hetch-Hetchy Valley, 16 June, 1917, *A. L. Grant 984* (Cornell, M, Calif., and Stanford); Big Creek, Big Oak Flat Road, Tuolumne Co., 22 June, 1919, *Jepson 8342* (Calif.); Little Yosemite, 6300 ft. alt., 6 July, 1909, *Jepson 3161a* (Calif.); Hazel Green, 5–6 July, 1896, *Jepson 44m* (Calif.); Lake Merced, Yosemite Park, 13 July, 1911, *Jepson 4429* (Calif.); Yosemite Valley, 22 June, 1911, *Abrams 4464* (Stanford); Yosemite Valley, 4–12 July, 1901, *G. B. Grant 4242* (Stanford); Yosemite Valley, 12 June, 1891, *Fritchey 25* (M); near Wawona, 15 June, 1891, *Fritchey 86* (M); Graveyard Meadow, Fresno Co., 18 Aug., 1918, *A. L. Grant 1514a* (Calif.); bog, King's River Cañon, near entrance to Bubbs Creek, 15 June, 1921, *Ottley 1486* (Wellesley and Cornell); Huntington Lake, Fresno Co., 7000 ft. alt., 26 July, 1917, *A. L. Grant 1175* (Wellesley, Cornell, M, Ore., Calif., and Pomona); Huntington Lake, Fresno Co., 31 July, 1918, *A. L. Grant 1468* (U. S., Cornell, and M); Pine Ridge, Fresno Co., 15–25 June, 1900, *Hall & Chandler 212* (M and Stanford); second dry meadow creek crossing, Kern

River, 15 July, 1895, *Dudley 687* (Stanford); near Methusaleh Big Tree, region of Middle Tule River, 28 July, 1895, *Dudley 921* (Stanford); wet places, woods near Middle Tule River, 5000–6000 ft. alt., Apr.–Sept., 1897, *Purpus 5619* (M); Round Meadow, Tulare Co., July, 1902, *G. B. Grant 1930* (Stanford); Round Meadow, Giant Forest, 24 June–2 July, 1900, *Jepson 680a* (Calif.); Freeman Creek, Kern River, 7000 ft. alt., 28 June, 1912, *Jepson 4883* (Calif.); Kern River Cañon, 6500 ft. alt., 6 July, 1912, *Jepson 4980* (Calif.); Inverness, Marin Co., 13 Aug., 1922, *Jepson 9803* (Cornell); Swanton, Santa Cruz Co., 1912, *Rich* (Stanford); San Gabriel Mts., Los Angeles Co., 31 Aug., 1917, *F. Grinnell, Jr.* (Stanford); Swartout Canyon, desert slopes of San Gabriel Mts., 6500 ft. alt., 5 July, 1908, *Abrams & McGregor 648* (Stanford); Swartout Canyon, San Antonio Mts., 6800 ft. alt., 3–6 June, 1900, *H. M. Hall 1523* (Stanford); moist places, San Bernardino Mts., 14 July, 1899, *H. M. Hall 1292* (M and R. Mt.); Bear Valley, San Bernardino Mts., Aug., 1882, *Parish & Parish 1463* (M); wet bank near Strawberry Flat, San Bernardino Mts., 5500 ft. alt., 21 June, 1916, *Parish 10952* (Stanford); Little Bear Valley, San Bernardino Mts., Aug., 1884, *Parish & Parish 1463* (Stanford); Hunsaker Flats, San Bernardino Mts., 5200 ft. alt., 8 June, 1919, *Munz & Johnston 2858* (Pomona); wet meadow, Tahquitz Valley, San Jacinto Mt., 7500 ft. alt., 8 Aug., 1903, *Jepson 2300* (Calif.); San Jacinto Mts., 6000 ft. alt., 1 July, 1892, *Hasse* (M); near brook in woods, Idyllwild, San Jacinto Mt., 5300 ft. alt., 1 July, 1921, *Spencer 1288* (Pomona); Smith Mt., 4500 ft. alt., July, 1895, *Stokes* (Stanford); Smith Mt., San Diego Co., 25 July, 1882, *Orcutt 432* (M).

An interesting aberrant form has been noted by J. K. Henry in some plants he collected on Vancouver Island. All the petals were lobed with a cuspidate point at the base of each notch. The specimens of Mrs. K. Brandegee, collected at Giant Forest, Tulare Co., California, have emarginate petals.

46b. Var. **sessilifolius** Gray, Syn. Fl. N. Am. ed. 2, 2^1: Suppl. 447. 1886; Curran in Proc. Calif. Acad. Sci. II, 1: 262. 1888; Greene, Manual Bay Region, 276. 1894; Jepson, Fl. W.M id.

Calif. 408. 1901, and ed. 2, 380. 1911; Abrams, Fl. Los Angeles, 366. 1904, and ed. 2, 336. 1917; Henry, Fl. Brit. Columbia, 268. 1915.

M. inodorus Greene in Bull. Calif. Acad. Sci. 1: 119. 1885.

Stems more nearly erect; upper leaves closely sessile by a broad base, lower leaves sometimes short-petioled; pedicels divaricate, elongated, often as long as the leaves, calyx 9–11 mm. long, enlarging in fruit, teeth unequal, sometimes one-half the length of the tube; corolla 2–3 cm. long.

Distribution: in wet places from British Columbia to southern California.

Specimens examined:

British Columbia: river bottoms, Vancouver Island, 7 Aug., 1902, *Rosendahl 895a* (M and R. Mt.); near Esquimault Harbor, Vancouver Island, 8 Aug., 1899, *Barber 179* (G); Elk Creek, near Victoria, 13 June, 1908, *Macoun 87657* (G).

Washington: Clallam, July, 1900, *Elmer 2589* (M, Stanford, and Pomona); Seattle, 26 June, 1889, *E. C. Smith* (M); Seattle, July, 1915, *Freiberg* (M); Seattle, 18 May, 1910, *Zeller* (M); Tacoma, 28 May, 1896, *Flett 130* (Cornell); Trout Lake, near Friday Harbor, 18 Sept., 1904, *Berg 10* (Stanford); near Montesano, Chehalis Co., 27 June, 1898, *Heller & Heller 3961* (G, Cornell, and M); Brooklyn, King Co., 20 June–12 July, 1898, *Savage, Cameron & Lenacker* (M).

Oregon: Oregon, 1871, *E. Hall 376* (G and M); gravelly stream bank, Salem, 31 May, 1915, *J. C. Nelson 202* (Stanford).

California: near Sisson, Siskiyou Co., 24 July–10 Aug., 1894, *Jepson 43m* (Calif.); Squaw Creek Ranger Station, Shasta Co., June, 1916, *Drew* (Stanford); rocks along South Yuba River, Nevada Co., 14 June, 1893, *Dudley* (Stanford); Chico, 1885, *Gray* (G); moist open places, Butte Meadows, Butte Co., 26 July, 1917, *Heller 12829* (Cornell, M, and Stanford); Arcata to Trinidad, Humboldt Co., 18 July, 1916, *Abrams 6107* (Stanford); Albion River, Mendocino Co., May, 1902, *McMurphy 297* (Stanford); Ft. Bragg, 1914, *Mathews 135* (Calif.); in ditch by roadside, Fort Bragg, Mendocino Co., 25 June, 1921, *Ottley 1516* (Wellesley, M, and Cornell); Wolf Creek between Willits and Laytonville, Mendocino Co., 6 July,

1916, *Abrams 5836* (Stanford); forest near Little Lake, Mendocino Co., June, 1882, *Rattan* (Stanford); Guerneville, Sonoma Co., 14 June, 1877, *Rattan* (Stanford); Howell Mt., June and Sept., 1888, *K. Brandegee* (M and Stanford); Angwin's Meadows, Howell Mt., 26 June, 1893, *Jepson 47m* (Calif.); Horse Mt., N. Lake Co., July–Aug., 1893, *Jepson 48m* (Calif.); Mill Valley, Marin Co., 19 July, 1891, *Jepson 49m* (Calif.); Gilroy to Santa Cruz, 16 June, 1896, *Jepson 50m* (Calif.); Boulder Creek, Santa Cruz Co., 3 Aug., 1902, *H. A. Walker 713* (Pomona); Santa Cruz, 20 June, 1903, *C. H. Thompson* (M); springy places near Glendale, Los Angeles Co., 5 June, 1888, *Hasse* (Stanford); Fredalba, San Bernardino Mts., 22 July, 1902, *Abrams 2800* (M); along small stream, Big Bear Valley, 6500 ft. alt., 4 July, 1920, *Harwood 4347* (Pomona); Swartout Valley, San Antonio Mts., 7500 ft. alt., 17 June, 1921, *Munz 4615* (Pomona); wet bank, Strawberry Flat, San Bernardino Mts., 5500 ft. alt., 21 June, 1916, *Parish 10951* (Stanford); California, 1891, *Hartweg* (G).

47. M. Leibergii Grant[1] Pl. 6, fig. 1.

A low, loosely branched, glabrous perennial; stems 2–3 dm. long, weak, reclining or suberect, rooting from the nodes; leaves thin, ovate or oblong, 1.8–3 cm. long, 7–13 mm. broad, acute or obtuse, denticulate, mostly with short winged petioles, pinnately-veined, internodes and ascending pedicels longer than the leaves; calyx campanulate, 1–1.3 cm. long, not accrescent, minutely puberulent, teeth triangular-subulate, 3–4 mm. long, equal, recurved, minutely ciliate; corolla 1.8–2 cm. long, pale pink, tube included, throat funnelform with a hairy ring at the base of the lobes and two densely hairy ridges below the lower lip, lobes apparently nearly equal, little spreading; stamens and style included, glabrous, filaments flattened, stigma-lips equal,

[1] **Mimulus Leibergii** Grant, sp. nov., perennis glabrus; caulibus infirmis, resupinis suberectisve, 2–3 dm. longis; foliis tenuibus, ovatis oblongisve, fere brevi-petiolatis, penninervibus, denticulatis; pediculis foliis longioribus; calyce 1–1.3 cm. longo, dentibus triangulari-subulatis, 3–4 mm. longis; corolla pallida rosea, 1.8–2 cm. longa.—Collected in wet soil along creek on Mt. Pleasant of the Spanish Peak Range, California, 6500 ft. alt., 16 July, 1900, *John B. Leiberg 5171* (U. S. Nat. Herb., no. 610415, TYPE).

broadly rounded; capsule ovate, acute, as long as the calyx-tube, placentae adherent to the apex; seeds oval, favose-areolate.

Distribution: known only from the type locality.

Specimens examined:

California: in wet soil along creek on Mt. Pleasant of the Spanish Peak Range, 6500 ft. alt., 16 July, 1900, *Leiberg 5171* (U. S., TYPE).

48. **M. alsinoides** Dougl. in Benth. Scroph. Ind. 29. 1835; Hook. Fl. Bor. Am. 2: 100. 1840; Benth. in DC. Prodr. 10: 372. 1846; Gray in Proc. Am. Acad. 11: 98. 1876; Syn. Fl. N. Am. 2^1: 277. 1878, ed. 2, and Suppl. 449. 1886; Greene in Bull. Calif. Acad. Sci. 1: 115. 1885; Howell, Fl. Northwest Am. 521. 1901; Piper, Fl. Northwest Coast, 324. 1915; Henry, Fl. Brit. Columbia, 269. 1915.

M. alsinoides β *paniculatus* Benth. Scroph. Ind. 29. 1840.

Stems nearly glabrous, erect, simple or more often diffusely branched, 4–30 cm. long; leaves broadly ovate or rhomboid-ovate, 2–6 cm. long, 1–3 mm. wide, thin, glabrous, yellowish-green, irregularly dentate, 3–5-nerved, the base sometimes truncate but more often narrowed abruptly to the long-margined petiole, the latter at least as long as the blade; internodes and the erect or spreading filiform pedicels usually longer than the leaves; calyx 4–6 mm. long, narrow, oblong, minutely puberulent, plicate-angled, fruiting calyx 7–9 mm. long, not inflated, teeth unequal, the 2 lower ones truncate and longer than the 3 short triangular-acute or mucronate upper ones; corolla bilabiate, funnelform, 1–1.3 cm. long, yellow, tube slightly exserted, lobes erose or emarginate, the middle lobe of the lower lip spreading and nearly twice as long as the lateral lobes or the 2 erect upper ones and with a large reddish spot near its base; stamens glabrous, the upper pair slightly exserted; style glabrous, exserted, stigma-lips unequal, oblong; capsule oblong-acuminate, usually slightly exserted, placentae adherent to the apex; seeds oblong, smooth.

Distribution: in wet places from British Columbia to northern California.

Specimens examined:

British Columbia: Esquimalt, Vancouver Island, 12 June, 1901,

Macoun 87669 (Cornell); Chilliwack Valley, 29 June, 1901, *Macoun 54483* (G and M); vicinity of Victoria, 8 May, 1893, *Macoun 703* (G); Victoria, 18 April, 1900, *Pineo* (Calif.); Vancouver, July, 1913, *Henry* (R. Mt.).

Washington: in shade on damp rocks, Columbia River, W. Klickitat Co., 21, 23 May, 1884, *Suksdorf 687* (M); damp cliffs in shade, Columbia River, W. Klickitat Co., 23 May, 1884, *Suksdorf 420* (G); dry bluffs, La Camas, 31 May, 1884, *Henderson* (Stanford); Columbia River, *Nuttall* (G).

Oregon: wet sunny bluffs, Portland, 17 April, 1884, *Henderson* (Stanford); Rooster Rock, May, 1884, *Howell* (Stanford); rocky places, western Oregon, April, May, 1880, *Howell* (M); opposite Oswego, 17 May, 1893, *Howell 454* (R. Mt. and Calif.); Willamette, 1877, *Howell* (G); wet rocks, Multnomah Falls, 8 April, 1914, *Peck 5623* (G); Multnomah Falls, April, 1884, *Howell* (Phil.); Rock Spur, Clackamas Co., 17 April, 1903, *Sheldon 11863* (Stanford); Brookings, June, 1916, *Thompson 140* (Stanford); rock crevices, Falls City, 12 May, 1917, *J. C. Nelson 1136* (G); The Dalles, April, 1886, *Davidson* (Pomona); on rocks, Dalles, 12 April, 1903, *Lunnell* (G); Oregon, 1871, *E. Hall 378* (Phil. and M); Oregon, 1868–1869, *Kellogg & Harford 683* (G).

California: 1 May, 1876, *Greene 734* (Phil. and M); near Kneeland Prairie, Humboldt Co., June, 1882, *Rattan* (G and Stanford); wet bank in brush patch, Kneeland Prairie, Humboldt Co., 8 June, 1908, *Tracy 2634* (Calif.).

48a. Var. **minimus** Benth. Scroph. Ind. 29. 1835; DC. Prodr. **10**: 372. 1846; Hook. Fl. Bor. Am. **2**: 100. 1840; Gray in Proc. Am. Acad. **11**: 98. 1876; Syn. Fl. N. Am. **2**^{1}: 277. 1878, ed. 2, and Suppl. 449. 1886.

Very small plants, 1–3.5 cm. high; calyx 3–5 mm. long; corolla 5–7 mm. long; stamens exserted; capsule included.

Distribution: British Columbia and Washington.

Specimens examined:

British Columbia: Vancouver Island, 1859–60, *Wood* (G).

Washington: Columbia River, *Scouler 182* (G and N. Y.); Cascade Mts. to Fort Coville on Oregon Boundary Commission, 1860, *Lyall* (G).

M. alsinoides is most closely related to *M. Pulsiferae* with which it has often been confused. The unequal calyx-teeth, 2 of which are truncate and longer than the 3 triangular-acute upper ones, distinguish this species from any other *Mimulus* except *M. pachystylus.*

49. M. pachystylus Grant[1]

A low creeping perennial; stems 1–3 dm. long, viscid-pilose, with long soft hairs, prostrate, rooting freely from the nodes, 1–3 dm. long; leaves broadly ovate, 1–3 cm. long, .5–2 cm. wide, acute, coarsely dentate, pinnately-nerved, thick and usually glabrous, petioles short, viscid-pilose; flowers axillary, pedicels shorter than the leaves, densely viscid-pilose; calyx broadly campanulate, 9–10 mm. long, nearly glabrous, teeth short, broadly truncate, mucronate, the 2 upper teeth longer than the 3 lower ones, sometimes with smaller teeth in between, throat oblique; corolla bilabiate, 1.3–1.4 cm. long, broadly funnelform, apparently yellow, tube broad, included, throat slightly exserted, ampliate, with two densely bearded ridges below the lower lip, lobes unequal, broad, rounded; stamens glabrous, included, the upper pair sometimes longer than the style, anthers joined at least half their length; style glabrous, much thickened, sometimes with a swollen base, stigma-lobes broad, rounded, laciniate, equal; capsule ovate, attenuate, placentae adherent to the apex; seeds oval, apiculate at one end, favose areolate.

Distribution: known only from Chiapas, Mexico.

Specimens examined:

Chiapas: Cerro del Boqueron, Aug., 1913, *Purpus 7015* (U. S. and M, TYPE).

[1] **Mimulus pachystylus** Grant, sp. nov., perennis repens; caulibus viscido-pilosis, prostratis, 1–3 dm. longis; foliis late ovatis, acutis, crasse dentatis, 1–3 cm. longis, laminibus crassis, fere glabris; petiolis brevibus, pilosis, pediculis foliis brevibus, dense viscido-pilosis; calyce prope glabro, 9–10 mm. longo, dentibus brevibus, duobus supremis tribus inferioribus longioribus; corollae labiis inaequalibus 1.3–1.4 cm. longis; staminibus glabris; stylo glabro, crasso, stigmae laciniis aequalibus; capsula ovata, attenuata.—Collected at Cerro del Boqueron, Aug., 1913, *C. A. Purpus 7015* (U. S. Nat. Herb., and Mo. Bot. Gard. Herb., no. 741579, TYPE).

50. M. Dudleyi Grant[1] Pl. 4, fig. 2.

Stems 8–15 cm. high, viscid-villous; leaves thin, broadly ovate, 2–3 cm. long, 1–2 cm. wide, acute, saliently dentate, truncate or rounded at the base, light green above and frequently tinged with red below, pinnately-veined, sparsely villous; pedicels slender, almost filiform, villous, longer than the leaves, erect in flower, spreading in fruit; calyx campanulate, 6–7 mm. long, usually tinged with red, densely viscid-villous with long white hairs, slightly inflated and broadly oval in fruit, constricted at the orifice, teeth equal, triangular-acute, ciliate, 2 mm. long; corolla somewhat bilabiate, 1.7–2.2 cm. long, yellow, tube cylindrical, almost twice as long as the calyx, throat very short, abruptly expanding to the broad spreading unequal lobes, 4–8 mm. long, the lower lip longer than the upper one and closely streaked with red toward the throat; stamens glabrous, included in the tube and inserted near its base; style little longer than the stamens, stigma-lips equal; capsule oblong, acute, shorter than the calyx-tube, placentae firmly adherent; seeds oval, slightly papillate.

Distribution: known only from Tulare Co., California.

Specimens examined:

California: rocky cliffs east of the Tule River, Tulare Co., 27 March, 1897, *Dudley* (Stanford, TYPE); Tulare Co., April, 1897, *Davy* (Pomona).

51. M. Parishii Greene in Bull. Calif. Acad. Sci. **1**: 108. 1885; Gray, Syn. Fl. N. Am. ed. 2, 2[1]: Suppl. 450. 1886; Abrams, Fl. Los Angeles, 366. 1904, and ed. 2, 336. 1917.

A stout, erect, densely glandular-villous annual; stem 1.5–4 dm. high, simple or mostly branching from the base; leaves ovate to lanceolate-oblong, 1.5–5 cm. long, .3–1.7 cm. wide, clasping by a broad sessile base, irregularly dentate, obscurely 3-nerved, grayish-green; inflorescence paniculate; pedicels slender, shorter

[1] **Mimulus Dudleyi** Grant, sp. nov., caulis viscido-villosus, 8–15 cm. longus; foliis late ovatis, acutis, petiolatis, acute dentatis; pediculis foliis longioribus; calyce 6–7 mm. longo, dentibus triangulari-acutis, aequalibus; corolla 1.7–2.2 mm. longa, flava, fauce brevi, laciniis latis, inaequalibus, labio inferiore rubro-lineato; staminibus styloque brevibus; stigmae laciniis aequalibus; capsula inclusa, oblonga.—Collected on rocky cliffs east of the Tule River, Tulare Co., 27 March, 1897, *W. R. Dudley* (Stanford Univ. Herb., no. 21830, TYPE).

than the leaves, erect, somewhat spreading; calyx oblong, membranaceous, pale grayish-green, 8–9 mm. long, fruiting calyx 1–1.2 cm. long, not inflated, teeth short, 1–2 mm. long, equal, broadly deltoid-acute, the margins sparsely glandular-ciliate; corolla pale pink to rose or lilac, rarely white, 1–1.3 cm. long, tube and throat included, lobes subequal, exserted, erect, truncate or rounded and slightly erose; stamens included, glabrous; style and stigma slightly exserted, glabrous; stigma-lips unequal, oblong; capsule included, chartaceous; seeds oblong, smooth, apiculate at each end.

Distribution: along streams in the desert mountain regions of southern California.

Specimens examined:

California: Cox's Ranch, Mohave River, Aug., 1882, *Parish & Parish 1465* (U. S., F, Calif., and Stanford, *type collection*); Rock Springs, north side of San Bernardino Mts., June, 1886, *Parish 1460* (U. S. and Greene); Rock Springs, north side of San Bernardino Mts., 13 June, 1888, *Parish* (U. S.); Rock Springs, borders of Mohave Desert, June, 1886, *Parish* (Calif.); Rock Creek, 1 Aug., 1901, *Davidson* (Stanford); Rock Creek, San Gabriel Mts., 4750 ft. alt., 16 June, 1918, *Pierson 199* (Calif.); Rock Creek, San Gabriel Mts., 3800 ft. alt., 2–4 July, 1908, *Abrams & McGregor 559* (U. S. and Stanford); Los Angeles Co., June, 1884, *Nevin 1068* (G); Big Meadows, San Bernardino Mts., 7000 ft. alt., 26 July, 1906, *H. M. Hall 7571* (M, R. Mt., and Calif.); river banks, Victorville, 25 June, 1915, *Parish 10537* (G and Stanford); Palm Cañon, near Mt. San Jacinto, 22 May, 1901, *Jepson 1402* (Calif.); wet ground, Coyote Hole, Little San Bernardino Mts., 3000 ft. alt., 6 May, 1922, *Munz & Johnston 5202* (Pomona); wet sandy wash, Smith Water Canyon, near Quail Springs, Little San Bernardino Mts., 7 May, 1922, *Munz & Johnston 5215* (Pomona).

Mexico:

Lower California: San Rafael, northern Lower California, 19 Sept., 1884, *Orcutt* (M).

52. M. Lewisii Pursh, Fl. Am. Sept. **2**: 427, *pl. 20*. 1814; Benth. Scroph. Ind. 28. 1835; DC. Prodr. **10**: 370. 1846;

Gray in Proc. Am. Acad. 11: 98. 1876; Bot. Calif. 1: 566. 1876; Syn. Fl. N. Am. 2^1: 276. 1878, and ed. 2, 1886; Greene in Bull. Calif. Acad. Sci. 1: 108. 1885; Howell, Fl. Northwest Am. 519. 1901; Piper, Contr. U. S. Nat. Herb. 11: 508. 1906; Fl. Southeast Wash. and Adj. Idaho, 227. 1914; Nelson in Coulter & Nelson, Manual Cent. Rocky Mountains, 453. 1909; Hall, Yosemite Fl. 222. 1912. Pl. 8, fig. 2.

M. Lewisii var. *exsertus* Coult. & Fisher in Bot. Gaz. 18: 302. 1893.

M. roseus Dougl. in Bot. Reg. *pl. 1591.* 1833; Lodd. Bot. Cab. *pl. 1976.* 1833; Hook. in Curtis, Bot. Mag. II. 8: *pl. 3353.* 1834; D. Don, Brit. Flower Gard. 4: *pl. 210.* 1835.

M. roseus var. *glabrior* Hook. Fl. Bor. Am. 2: 100. 1840.

M. Lewisii var. *tetonensis* A. Nels. in Bot. Gaz. 34: 31. 1902.

M. Lewisii var. *alba* Henry, Fl. Brit. Columbia, 268. 1915.

M. Lewisii f. *tetonensis* (Nels.) Macb. & Pays. in Contr. Gray Herb. N. S. 49: 67. 1917.

Stems from a running rootstock, erect, 3–7.5 dm. high, mostly simple, the whole plant more or less viscid-pubescent; leaves thin, oblong or oblong-lanceolate to ovate-oblong, 2.5–7 cm. long, 1–2.7 cm. wide, 3–5-nerved from the base, irregularly dentate with short subulate teeth, occasionally almost entire, sessile by a broad base; pedicels erect, usually much longer than the leaves; calyx tubular or somewhat campanulate, often tinged or dotted with red, 1.5–2.5 cm. long, sharply angled, teeth mostly equal, broadly triangular at the base, becoming subulate, 4–6 mm. long; corolla 3.3–5.5 cm. long, rose-red to pale pink, with darker lines down the throat, often more or less blotched with red, occasionally white or yellowish-white, lobes rounded, erose or sometimes emarginate, nearly equal and little spreading, 8–10 mm. long, tube exserted, yellow or white below the lower lip, throat ampliate, sparingly bearded, sometimes spotted; stamens included, anthers more or less villous on the back with narrow, flattened hairs, filaments glabrous; style slightly longer than the stamens, stigma-lips broad and rounded; capsule oblong, included; seeds oblong, longitudinally wrinkled.

Distribution: common along streams above 4000 ft. alt., from the Rocky Mountain states west to British Columbia and Cali-

fornia. The type was collected by Meriwether Lewis on the Lewis & Clark Expedition.

Specimens examined:

Alberta: Glacier track, Alberta, 21 July, 1901, *Waldron 142* (R. Mt.).

British Columbia: Burnt Woods, Spillimacheen Valley, 6600 ft. alt., 3 Aug., 1904, *Shaw 434* (M and R. Mt.); by a rivulet, alpine meadow in the Big Bend District, 6000 ft. alt., 24 July, 1905, *Shaw 984* (M); west of Skagit River, 17 Aug., 1905, *Macoun 76792* (Pomona); Chilliwack Valley, 29 June, 1901, *Macoun 54485* (M); Griffin Lake, 6 July, 1890, *Macoun* (M); Glacier, July, 1896, *Dudley* (Stanford); Glacier, Asulkan Valley, 4100–6000 ft. alt., 19 July, 1906, *S. Brown 588* (Phil. and M).

Montana: Spanish Peaks, 20 July, 1901, *Vogel* (R. Mt.); stream margins, Sourdough Cañon, near Bozeman, 6000 ft. alt., 11 July, 1905, *Blankinship 390* (M); Granite Park, 6200 ft. alt., Aug., 1910, *Kirkwood 28, 29* (M and Pomona); Bozeman Cañon, 6000–7000 ft. alt., 27 July, 1898, *Blankinship* (M); Helena, July, 1892, *Starz* (M); stream beds, Yellowstone Lake shore, 8000 ft. alt., 1 Aug., 1907, *Essig* (Pomona); Mountain Pass, Sperry Glacier, 1 Sept., 1903, *Umbach 796* (Stanford); MacDougal Peak, 31 July, 1908, *Clemens* (Stanford); Summit, Swan Mts., 6500 ft. alt., 5 Aug., 1906, *Elrod* (Stanford); mountain streams, White Sulphur Springs, 6500 ft. alt., 16 July, 1883, *Scribner 189* (Phil); Summit, Great Northern Railway, 25 July, 1894, *R. S. Williams* (R. Mt.).

Wyoming: wet banks, Little Goose Cañon, Sheridan Co., 28 July, 1901, *Nelson 8523* (Cornell, M, and R. Mt.); near stony water courses, Centennial, Albany Co., 7 Aug., 1900, *Nelson 6276* (M, R. Mt., and Pomona); in creeks, Bridger Peak, Carbon Co., 22 Aug., 1903, *Goodding 1956* (M and R. Mt.); Centennial Valley, 16 July, 1895, *Nelson 1672* (Cornell, R. Mt., and M); borders of alpine brooks, 1873, *Parry 212* (M); Saratoga, 11 June, 1892, *Buffum 702* (R. Mt.); Teton Peaks, 21 Aug., 1894, *Nelson 3531* (R. Mt.); rocky creek bed, near Camp Fox, 13 Aug., 1899, *Wilkerson 10* (R. Mt.); summit of Teton's above Lee's Lake, 11000 ft. alt., 26 July 1901, *Merrill & Wilcox 1072* (G and R. Mt.); along stream, Teton Pass,

12 July, 1901, *Merrill & Wilcox 971* (G and R. Mt.); growing in damp soil between rocks, Willits Creek, 11 Aug., 1909, *Willits 364* (R. Mt.).

Idaho: near Sohons Pass, 1 Aug., 1895, *Leiberg 1424* (R. Mt. and Stanford); by running water, Trinity, Elmore Co., 10 Aug., 1910, *Macbride 571* (M, R. Mt., and Stanford); Silver City, July, 1892, *Mulford* (M); Silver City, 18 July, 1910, *Macbride 414* (M, R. Mt., and Stanford); Owyhee Mts., July, 1892, *Mulford* (M); near Sawtooth Mountain on west shore of Alturas Lake, 8000–8500 ft. alt., 26–28 July, 1896, *Evermann 650* (Stanford); Wieser Forest, Indian Valley, 14 Aug., 1917, *Marsh 14165* (M); Payette Forest Reserve, 1912, *Mains D-70* (R. Mt.); Payette Forest Reserve, 1 Aug., 1911, *Miles 206* (R. Mt.); base of Galena Summit, Blaine Co., 12 Aug., 1916, *Macbride & Payson 3731* (G and R. Mt.).

Utah: Rush Creek, Washington Co., 4000 ft. alt., 10 July, 1899, *Jones 6486* (M); moist shady places, Peterson Cañon, Peterson, 19 July, 1902, *Pammel & Blackwood 3813* (M); near Clayton Peak, Wasatch Mts., 9000 ft. alt., 12–26 Aug., 1903, *Stokes* (M); Wasatch Mts., Big Cottonwood Canyon, Salt Lake Co., 21 Aug., 1905, *Garrett 1645* (Phil.); Alta, Aug., 1879, *Jones* (R. Mt.); Ogden, Aug., 1885, *Letterman 80* (M); Bear River Cañon, 8000 ft. alt., Aug., 1869, *Watson* (N. Y.).

Nevada: Slide Mt., Washoe Co., 7500 ft. alt., 11 July, 1910, *Heller 10203* (Stanford); Clear Creek Cañon, Ormsby Co., 5 July, 1902, *C. F. Baker 1248* (M, R. Mt., and Pomona); Rattlesnake Canyon near Lee Post Office, Elko Co., 8900 ft. alt., 25 Aug., 1908, *Heller 9564* (M).

Washington: slopes of Mt. Stuart, 2500–3500 ft. alt., 24 July, 1893, *Sandberg & Leiberg 557* (M); brooks, Nisqually Glacier, Mt. Rainier, 21 July, 1907, *Cowles 798* (M); Mt. Rainier, 6000 ft. alt., 16 Aug., 1889, *E. C. Smith* (M); Mt. Rainier, 4000–6500 ft. alt., 11 Aug., 1897, *Allen 276* (M and Stanford); Clallam, Olympic Mts., Aug., 1900, *Elmer 2572* (M and Stanford); Lake Chelan, 17 Aug., 1892, *Lake & Hull* (M and R. Mt.); Wellington, Snohomish Co., July, 1898, *Savage, Cameron & Lenacker* (M); Stevens Pass, Aug., 1893, *Sandberg & Leiberg* (M and Pomona); Yakima Region, 1882, *T. S. Brandegee 226*

(M); North Fork of Bridge Creek, Okanogan Co., Sept.,1897, *Elmer 646* (M and Pomona); Mt. Adams, 7 Aug., 1882, *Henderson 754* (Ore.); Mt. Paddo, 30 July, 1906, *Suksdorf 5779* (M and Stanford); Mt. Paddo, 31 Aug., 1882, *Suksdorf* (Phil.); The Meadows, Mt. Baker, 23 Aug., 1910, *Muenscher 965* (Cornell).

Oregon: subalpine stream banks, 4000–6000 ft. alt., eastern Oregon, 1897, *Cusick 1727* (Cornell, M, and Stanford); Bear Creek, Wallowa Co., 3800 ft. alt., 27 Aug., 1897, *Sheldon 8806* (G, U. S., M, and R. Mt.); Strawberry Lake, Strawberry Mts., Whitman Forest, Grant Co., 16 Sept., 1916, *Eggleston 13695* (M); Cherry Creek Canyon, Crater Nat. Forest, Klamath Co., 4500 ft. alt., 26 June, 1919, *Rose 1310* (M); Stanley Range, Imnaha National Forest, 7000 ft. alt., 10 Aug., 1907, *Sampson & Pearson 132* (M); Crater Lake, 30 Aug., 1916, *Heller 12620* (Cornell, Ore., and Stanford); Crater Lake, Aug., 1897, *Austin & Bruce* (Stanford); Mt. Hood, 6000 ft. alt., 9 Aug., 1914, *Jackson & Standley* (Ore.); Mt. Hood, 7000 ft. alt., 10 Aug., 1893, *Langille* (U. S.); Mt. Hood, Aug., 1886, *Howell* (Ore.); Mt. Hood, 7000 ft. alt., 25 Aug., 1899, *Barber 222* (G and R. Mt.); Oregon, *Douglas* (G).

California: Lincoln Valley, 19 July, 1901, *Kennedy 190* (R. Mt. and Stanford); Summit, Soda Springs, 10 Aug., 1901, *Kennedy 269* (R. Mt.); Lake Tahoe, July, 1897, *Blasdale* (R. Mt. and Pomona); Donner Lake, Aug., 1883, *Greene* (M); Truckee, Aug., 1890, *Sonne 262* (M); Summit, July, 1877, *Edwards 505* (M); Eldorado Co., 1866, *Rattan* (Stanford); Glen Alpine, Eldorado Co., 7000 ft. alt., 12 July, 1898, *Price* (Stanford); Heather Lake, Eldorado Co., 7900 ft. alt., 28 Aug., 1918, *Jepson 8165* (Calif.); shore of Glen Alpine stream, Eldorado Co., 12 July, 1909, *Lathrop* (Stanford); Lake of the Woods, Lake Tahoe Region, 8 Aug., 1909, *McGregor 40* (Stanford); near Echo Camp, Eldorado Co., 6 Aug., 1915, *Heller 12155* (Cornell, M, Ore., and Stanford); ravines on Truckee River, Placer Co., 10 Aug., 1884, *Sonne* (Stanford); ridge above Donner Pass, 7500 ft. alt., 10 Aug., 1903, *Heller 7141* (M, Deam, R. Mt., Stanford, and Pomona); Bear Valley, Sierras, *Lemmon* (Stanford); Hope Valley, Alpine Co., Aug., 1892,

Hansen 471 (M and Stanford); Bear Valley, Calaveras Co., 6000 ft. alt., Aug., 1892, *Hansen 462* (M and Stanford); Big Oak Flat Road, below Crocker's, 19 July, 1918, *Ferris 1459* (Stanford); Conness Creek, Yosemite Park, 7800 ft. alt., 20 July, 1911, *Jepson 4480* (Calif.); Yosemite, 1883, *Meehan* (Phil.); Mt. Hoffman, 8500 ft. alt., July, 1901, *Evans* (Stanford and Pomona); Chilmalua Creek, Mariposa Co., 12 Aug., 1895, *Congdon* (Stanford); Matterhorn Cañon, Sierra Nevada Mts., 8800 ft. alt., 20 July, 1909, *Jepson 3367* (Calif.); above Pumice Flat, Madera Co., 22 Aug., 1918, *A. L. Grant 1567* (M); Carson Pass, 8300 ft. alt., 23 Aug., 1918, *Jepson 8111* (Calif.); region of Dinkey Creek, Fresno Co., 5300 ft. alt., 25 June–15 July, 1900, *Hall & Chandler 352* (M and Stanford); Huntington Lake, Fresno Co., 7200 ft. alt., 16 July, 1917, *A. L. Grant 1116* (M and Calif.); Daugherty Meadow, North Fork Kaweah River, 26 July, 1896, *Dudley 1430* (Stanford); vicinity of Alta Peak, Sequoia National Park, 6000–8000 ft. alt., 1 Aug., 1896, *Dudley 1553* (Stanford); Langworthy's near North Fork, Sierra National Forest, 16 July, 1912, *Abrams 4950* (Stanford); King's Cànyon road west of Carson, 31 Aug., 1901, *Steinmetz* (Stanford).

M. Lewisii exhibits wide variations in the size of the leaves and in the length of the corolla-tube, but in a long series of specimens all intermediate stages may be found. *M. roseus* Dougl. is doubtless a synonym of *M. Lewisii*, though the descriptions and many of the old colored plates indicate that the pedicels were shorter than the leaves. In the specimens of Douglas at the Gray Herbarium, the pedicels are longer than the leaves whereas in the one at the New York Botanical Garden some pedicels are longer and some are shorter than the leaves. This latter specimen, together with those of *M. E. Jones 6486* from Rush Creek, Utah, *Rose 1310* from Oregon, and *Cusick 1727* from eastern Oregon, are the only ones having short pedicels that have been seen by the writer. Occasionally white or yellowish-white flowers are collected, *Merrill & Wilcox 1072*, *Macbride & Payson 3731*, *Suksdorf 5779*, and *Hansen 471* being good examples of these color forms.

53. **M. Eastwoodiae** Rydb. in Bull. Torr. Bot. Club **40**: 483. 1913; Fl. Rocky Mountains, 779. 1917.

M. cardinalis Eastw. in Proc. Calif. Acad. Sci. II. **6**: 312. 1896, not Dougl.

Plants usually densely woolly-canescent; stems terete, short, more or less procumbent, from a creeping rootstock or from short stolons; leaves broadly obovate or oblong, 2–5 cm. long, .5–2 cm. wide, acute, coarsely and saliently dentate along the upper half, tapering to a broad sessile base, the lower leaves sometimes spatulate or cuneate, frequently reddish on the lower surface; flowers few, mostly solitary; pedicels slender, usually longer than the leaves; calyx somewhat funnelform, 2.2–2.7 cm. long, teeth triangular, acute or subulate, ciliate, slightly unequal, 4–6 mm. long; corolla 3.5–4 cm. long, crimson, tube broadly funnelform, exserted less than twice its length, more or less tinged with yellow, throat ampliate, upper lip erect, lower erect or somewhat spreading, lobes nearly equal, emarginate; stamens much exserted, anthers yellow, densely bearded; style and stigma nearly as long as the corolla, stigma narrowly oblong to spatulate; capsule unknown.

Distribution: in wet, shaded places in Utah, Nevada, and Arizona.

Specimens examined:

Utah: along San Juan River, near Bluff, 3600–7000 ft. alt., 25–29 Aug., 1911, *Rydberg & Garrett 9883* (N. Y., TYPE, and R. Mt.); Springdale, 4000 ft. alt., 16 May, 1894, *Jones 5349* (U. S. and Pomona).

Arizona: abundant, but only in complete shade in wet caves or recesses under cliffs, on wet walls, Navajo Reservation, July, 1916, *Vorhies* (G, N. Y., and M); Betatakin ruin, Navajo Indian Reservation, 9 July–24 Aug., 1919, *Clute 128* (R. Mt.).

Nevada: Wheeler's Expedition, 1872, no collector given (U. S.).

This species is peculiar in producing stolons by means of which the plant propagates itself. These stolons, according to Rydberg, root freely at the nodes.

54. **M. primuloides** Benth. Scroph. Ind. 29. 1835; DC. Prodr. **10**: 372. 1846; Hook. Fl. Bor. Am. **2**: 100. 1840; Regel, Gar-

tenfl. **21**: 293, *pl. 739.* 1872; Gray in Proc. Am. Acad. **11**: 99. 1876; Bot. Calif. **1**: 569. 1876; Syn. Fl. N. Am. **2**[1]: 279. 1878, ed. 2, and Suppl. 446. 1886; Greene in Bull. Calif. Acad. Sci. **1**: 120. 1885; Howell, Fl. Northwest Am. 552. 1901; Piper, Contr. U. S. Nat. Herb. **11**: 509. 1906; Hall in Univ. Calif. Publ. Bot. **1**: 118. 1902; Yosemite Fl. 220. 1912; Rydb. Fl. Rocky Mountains, 780. 1917; Smiley in Univ. Calif. Publ. Bot. **9**: 331. 1921. Pl. 8, fig. 3.

M. pilosellus Greene in Erythea **4**: 22. 1896; Howell, Fl. Northwest Am. 522. 1901.

M. nevadensis Gdgr. in Bull. Soc. Bot. Fr. **19**: 218. 1919.

M. primuloides var. *pilosellus* (Greene) Smiley in Univ. Calif. Publ. Bot. **9**: 332. 1921.

A variable perennial, stoloniferous, or reproducing by surface runners or by bulbils attached to the underground stems, subacaulescent with radical leaves or the stems 3–10 cm. high, bearing several pairs of leaves, internodes close together or almost as long as the leaves, glabrous or viscid-pilose with long soft hairs; leaves broadly obovate, oblong or sometimes cuneate, tapering to a narrow, somewhat connate, sessile base, 1–2.5 cm. long, 5–7 mm. broad, light green to gray-green, thin, entire or dentate, occasionally with an undulate margin, 3–5-nerved, glabrous or with long, white, jointed hairs scattered on the upper surface; flowers few, mostly solitary, scapose, pedicels 4–10 cm. long, glabrous, slender, elongated; calyx tubular, 4–8 mm. long, weakly angled, glabrous, often tinged with red, teeth broadly triangular-acute, frequently mucronate, equal, mostly ciliate; corolla funnelform, .8–2 cm. long, yellow, sometimes with reddish-brown spots on the lobes and down the throat below the lower lip, tube exserted, less than twice as long as the calyx, throat ampliate, lobes spreading, emarginate or obcordate, the lower lip slightly longer than the upper; upper pair of stamens exserted, anthers hispid, rarely glabrous, filaments glabrous; style exserted, glabrous, stigma-lips oblong, unequal; capsule included, placentae separating at the apex; seeds oval, reticulate.

Distribution: growing in patches in moist meadows above 4000 ft. alt., from the Rocky Mountains to Washington, southward to southern California.

Specimens examined:

Idaho: mossy lake margins, Trinity Lake Region, 29 Aug., 1910, *Macbride 665* (R. Mt.); very wet meadow, Cape Horn, Custer Co., 6 Aug., 1916, *Macbride & Payson 3627* (M and R. Mt.).

Arizona: muddy places, Thompson Ranch, Bisbee, 12 July, 1900, *Goodding* (G).

Nevada: Snow Valley, Ormsby Co., 8 July, 1902, *Baker 1277* (M and Pomona); Franktown, Washoe Co., 5000 ft. alt., 28 June, 1909, *Heller 9786* (Phil. and Stanford).

Washington: Mt. Adams, 9 Aug., 1882, *Howell* (M); alpine banks, Mt. Adams, 8 Aug., 1882, *Henderson 755* (Ore.).

Oregon: swampy meadows of Summit Prairie, Blue Mts., Crook Co., 8 July, 1901, *Cusick 2649* (Cornell and R. Mt.); Ashland Butte, Siskiyou Mts., 19 July, 1887, *Howell 1243* (M and Ore.); wet meadow, Crescent, Klamath Co., 20 July, 1920, *Peck 9580* (M).

California: Shackleford Creek, Siskiyou Co., 4000 ft. alt., 9 July, 1910, *Butler 1699* (R. Mt.); along borders of mountain streams on Mt. Shasta, 6000 ft. alt., 22 Aug., 1880, *Engelmann* (M); near Sisson, 24 July–10 Aug., 1894, *Jepson 53m* (Calif.); Scott Mt., Siskiyou Co., 22 Aug., 1876, *Greene* (M); near Lassen Buttes, Plumas Co., 1–15 Aug., 1897, *H. E. Brown 603* (M); Plumas Co., 1876, *Austin* (M); Prattville, Plumas Co., 9 July, 1907, *Heller & Kennedy 8783* (M and Stanford); about Summit Station, Donner Pass, Nevada Co., 20 July, 1903, *Heller 6972* (M, R. Mt., Stanford, and Pomona); sandy flat near Yuba River, below Cisco, Placer Co., 5500 ft. alt., 25 July, 1919, *Heller 13309* (M and Cornell); Chico Meadows, Butte Co., 4000 ft. alt., 22 June, 1914, *Heller 11497* (Ore. and Stanford); Soldier's Ridge, Mendocino Co., 24 July, 1897, *Jepson 52m* (Calif.); Fallen Leaf, Eldorado Co., 21 June, 1920, *Ottley 815* (Wellesley and Cornell); Tahoe Tavern, Lake Tahoe, 15 July, 1909, *G. B. Grant 6923* (Stanford); Silver Lake, Amador Co., 8000 ft. alt., July, 1892, *Hansen 462* (M and Stanford); Summit Road near Sonora Pass, Tuolumne Co., 9000 ft. alt., 15 Aug., 1915, *A. L. Grant 291* (M, R. Mt., and Calif.); meadow near Mirror Lake, Yosemite Valley, 29 July, 1911, *Abrams 4571* (Stanford); vicinity of Tuolumne Meadows, 8500–9500

ft. alt., *Hall & Babcock 3533* (M, R. Mt., Stanford, and Pomona); near Snow Flat, Yosemite Park, 8700 ft. alt., July, 1901, *Evans* (Pomona); Mt. Lyell, 10000 ft. alt., 16 July, 1909, *Jepson 3341* (Calif.); near the Devil's Postpile, 21 Aug., 1918, *A. L. Grant 1563* (M); Jackass Meadow, Madera Co., 25 July, 1918, *A. L. Grant 1341* (Cornell, M, and Calif.); Graveyard Meadow, Fresno Co., 18 Aug., 1918, *A. L. Grant 1512a* (M); wet meadows above Mono Crossing, 5500 ft. alt., 15 Aug., 1918, *A. L. Grant 1511* (M); Pine Ridge, Fresno Co., 5400 ft. alt., 15–25 June, 1900, *Hall & Chandler 169* (M and Stanford); Nellie Lake, Fresno Co., 8400 ft. alt., 11 July, 1917, *A. L. Grant 1074* (G, M, and Ore.); Huntington Lake, Fresno Co., 7000 ft. alt., 26 July, 1917, *A. L. Grant 1177* (Cornell, M, and Calif.); Kaiser Peak, Fresno Co., 10000 ft. alt., 19 July, 1918, *A. L. Grant 1452* (M); Huckleberry Meadow between Hume and General Grant National Park, Fresno Co., 10 June, 1921, *Ottley 1448* (Cornell and Wellesley); Horse Corral Meadow, Sequoia National Forest, Fresno Co., 10 Aug., 1900, *Dudley 3168* (Stanford); near Mineral King, Sierra Nevada, 4 Aug., 1891, *Coville & Funston 1474* (Cornell and M); North Fork Crooked Creek, White Mts., 10000 ft. alt., 25 July, 1917, *Jepson 7266* (Calif.); Alta Meadow, Kern Co., 10000 ft. alt., 17 July, 1902, *G. B. Grant 1409* (Stanford); Big Meadow, Tulare Co., 7600 ft. alt., 6 Aug. 1900, *Dudley 3087* (Stanford); Kern River Valley, Tobias Meadow, Tulare Co., 10 July; 1895, *Dudley 605* (Stanford); above Kokopo Creek, region of Kaweah Peaks; Arroyo-Kern Divide, Tulare Co., 2 Aug., 1897, *Dudley 2437* (Stanford); Long Meadow, Tulare Co., 8000–9000 ft. alt., 7–14 June, 1888, *Edw. Palmer 161* (M); vicinity of Hockett Meadow, Grant National Park, 8000–9000 ft. alt., 15 July, 1897, *Dudley 1887* (Stanford); Buck Cañon Crossing, Tulare Co., 31 July, 1900, *Dudley 2942* (Stanford); Griffins, Ventura, July, 1902, *Elmer 3859* (M); Mt. Pinos, Ventura Co., 8400 ft. alt., 11 June, 1923, *Munz 7027* (Pomona); Bear Valley, San Bernardino Co., 6500 ft. alt., 24 June, 1894, *Parish 3076* (M, Calif., and Stanford); Cienega, between Bear Valley and Bluff Lake, San Bernardino Co., 30 July, 1902, *Abrams 2813* (M); San Bernardino Mountains, 6000 ft. alt.,

July, 1899, *H. M. Hall 1312* (M); Bluff Lake, San Bernardino Mountains, 6500 ft. alt., 21 June, 1894, *Parish 3077* (M and Stanford); Hunsaker Flats, San Bernardino Mountains, 5200 ft. alt., 8 June, 1919, *Munz, Williams & Corwin 2915* (Pomona); Round Valley, 9000 ft. alt., San Jacinto Mts., 1 Aug., 1916, *I. M. Johnston* (Pomona); Tahquitz Valley, San Jacinto Mts., 8000 ft. alt., July, 1901, *H. M. Hall 2349* (Stanford).

A beautiful perennial species suggesting the genus *Primula*, with its scapose, solitary flowers and its closely clustered basal leaves. It differs from most of the other members of this section by its habit of producing runners above ground and by its underground bulbils which appear on subterranean stems near the end of the growing season. Greene described the low, small-flowered, pilose plant as *M. pilosellus*, but in a full series of specimens every gradation in the size of the parts and in the amount and length of the pubescence may be found. Greene stated that the large and small forms hybridized and that this accounted for the numerous intermediates, but, so far, there is no evidence to support this theory.

54a. Var. linearifolius Grant[1]

Leaves linear to linear-oblong or sometimes spatulate, 2–4 cm. long, irregularly denticulate, obtuse or acute, glabrous or sparsely hirsutulous but not pilose; calyx 9–10 mm. long; corolla 2–2.5 cm. long.

Distribution: in the mountains in Siskiyou Co., California.

Specimens examined:

California: damp gravel bank, Shackleford Creek, 4000 ft. alt., 13 July, 1910, *Butler 1770* (M, R. Mt., and Stanford); Heather Meadow near the head of Wagon Creek Cañon, Mt. Eddy, 8500 ft. alt., 26 Aug., 1915, *Heller 12224* (G, U. S., Cornell, M, TYPE, Ore., and Stanford); Mt. Eddy, Siskiyou Co., 18 Aug., 1903, *Copeland*, distributed as *C. F. Baker 3830* (G, U. S., M,

[1] **Mimulus primuloides** Benth. var. **linearifolius** Grant, var. nov., folii lineari vel lineari-oblongi, inaequaliter denticulati, 2–4 cm. longi, glabri hirsutulosive, non pilosi; calyce 9–10 mm. longo; corolla 2–2.5 cm. longa.—Collected in Heather Meadow near the head of Wagon Creek Cañon, Mt. Eddy, Siskiyou Co., about 8500 ft. alt., 26 August, 1915, *A. A. Heller 12224* (Mo. Bot. Gard. Herb., no. 778352, TYPE).

and Pomona); meadow, foot of Mt. Eddy, 4 Aug., 1905, *Dudley* (Stanford); near Wagon Creek Falls, east side of Mt. Eddy, 29 June, 1919, *Heller* (M); Sisson, 6 July, 1914, *L. S. Smith 750* (G and U. S.).

The variety is easily separated from the species by its long, slender leaves and its larger calyx and corolla.

55. **M. bicolor** Benth. Pl. Hartw. 328. 1849; Gray in Proc. Am. Acad. **11**: 99. 1876; Bot. Calif. **1**: 568. 1876; Syn. Fl. N. Am. **2**[1]: 278. 1878, ed. 2, and Suppl. 450. 1886; Greene in Bull. Calif. Acad. Sci. **1**: 121. 1885; Eastwood, Fl. South Fork King's River, Sierra Club Publ. 27: 67. 1902; Hall, Yosemite Fl. 222. 1912. Pl. 10, fig. 4.

M. Prattenii Durand in Jour. Phila. Acad. Sci. II. **3**: 98. 1855.

Stems densely glandular-pubescent, 6–30 cm. high, simple or branched from the base; leaves few, obovate or oblanceolate or sometimes linear, 1.8–3 cm. long, 3–6 mm. broad, obtuse, yellowish-green, tapering to a slender petioled base, entire or serrulate, upper leaves sessile, internodes usually much longer than the leaves; inflorescence racemose, pedicels glandular-pubescent, mostly longer than the leaves, often spreading horizontally; calyx oblong, 6–10 mm. long, sparsely glandular-pubescent, often spotted with reddish-purple, distinctly angled, accrescent, the mature calyx campanulate, 1–1.2 cm. long, constricted at the throat and with more or less thickened, corky ribs, teeth triangular-acute, 2–3 mm. long, equal, spreading, not ciliate; corolla 1.6–2.5 cm. long, somewhat bilabiate, tube usually included, throat short, broad, funnelform, the ridges densely pubescent and spotted with red, lobes emarginate, the lower spreading, yellow, dotted with red and somewhat longer than the white upper one; stamens included, filaments slender, broad, glabrous, anthers hispid on the back; style slightly exserted, glabrous, stigma oblong with unequal, fimbriate lips; capsule oblong-linear, obtuse, placentae adherent to the apex; seeds oval, reticulate.

Distribution: common in meadows and along damp roadsides, from 2000–5000 ft. alt., throughout the Sierra Nevada Mts., California.

Specimens examined:

California: grade between Clear Creek and Paradise, Butte Co., 12 May, 1902, *Heller & Brown 5545* (Cornell, Phil., M, R. Mt., Stanford, and Pomona); abundant in moist, open places, near Forest Ranch, Butte Co., 2400 ft. alt., 17 May, 1914, *Heller 11338* (Cornell, M, Ore., and Stanford); De Sabla, Butte Co., June, 1917, *Edwards* (Stanford); near Cohasset, 28 May, 1915, *Heller 11905* (Cornell, M, Ore., and Stanford); Sacramento River, Butte Co., 1896, *Austin 163* (M); Eldorado Co., 1886, *Rattan* (Stanford); Amador Co., May, 1886, *T. S. Brandegee* (Stanford); Amador Co., May, 1886, *Curran* (Stanford); Rancheria, Amador Co., 2500 ft. alt., 9 June, 1896, *Hansen 1729* (M and Stanford); Antelope, Amador Co., 4000 ft. alt., June, 1895, *Hansen 1121* (M and Stanford); Panther Creek, Amador Co., 5000 ft. alt., May, 1895, *Hansen 1122* (M and Stanford); Big Trees, Calaveras Co., 5500 ft. alt., Aug., 1892, *Hansen 466* (M and Stanford); Big Trees, 1875, *Lemmon 1129½* (G); Avery's Station, Calaveras Co., 13 June, 1915, *A. L. Grant 3m* (Cornell and Calif.); Avery's Station, Calaveras Co., 8 June, 1917, *A. L. Grant 960* (M and Calif.); Table Mt., April, 1869, *Ames* (G); in shallow wash, Table Mt., above Rawhide, Tuolumne Co., 2000 ft. alt., 11–16 April, 1919, *Ferris 1490* (Stanford); Table Mt., near Columbia, 9 June, 1915, *A. L. Grant 2* (M and Stanford); Phoenix Lake, Tuolumne Co., 2000 ft. alt., 20 May, 1917, *A. L. Grant 950* (Wellesley and M); hills near Sonora, 12 May, 1854, *Bigelow* (G); Yosemite foothills, 1872, *Gray* (G); near Mammoth Grove, 15 May, 1854, *Bigelow* (G); Pine Ridge, Fresno Co., 5300 ft. alt., *Hall & Chandler 63* (M and Stanford); Esdeom Creek Redwoods, Kaweah River Valley Region, 23 July, 1896, *Dudley 1381* (Stanford); ridge between Pinehurst and Sequoia Lake, 3 June, 1921, *Ottley 1431* (Wellesley and Cornell); moist rocks, railroad above Alta, *Bolander* (M); valley of the San Joaquin, Aug., 1883, *Meehan* (Phil.); California, without date, *Parry* (M); California, *Hartweg 1892* (G, *type collection*).

M. bicolor is a beautiful plant, often occurring in such abundance as to color a considerable area. One patch covering over an acre was seen by the writer near Avery's Station, Calaveras

Co., in 1915. Mature specimens may readily be distinguished by the corky calyx-ribs, a character found also in *M. Bioletti*. As indicated by the name, the corolla in *M. bicolor* is usually white and yellow, but an interesting color form, in which the corolla is deep orange, occurs in many places where the typical form is found. The following collections illustrate this variation: Sugar Pine, Tuolumne Co., 3500 ft. alt., 10 June, 1917, *A. L. Grant 958* (M, G, N. Y., Calif., and Stanford); Wawona, Mariposa Co., 5000 ft. alt., 22 June, 1918, *A. L. Grant 1308* (Cornell, M, and Calif.); Snow Creek, Mariposa Co., 27 May, 1893, *Congdon* (Stanford). In the specimens of *A. L. Grant 958* from Tuolumne Co., the plants were abundant in large patches and only a few specimens of typical *M. bicolor* grew with them; in nearby places the two forms were in adjoining patches and in other places they were widely separated.

56. **M. Bioletti** Eastw. in Proc. Calif. Acad. Sci. III. **2**: 290. 1902.

An erect, glandular-pubescent annual; stems 5–15 cm. high, simple or branched; leaves few, oblanceolate, 1–2.5 cm. long, 2–6 mm. wide, tapering at both ends, sessile, entire or denticulate, the spatulate basal leaves usually slender-petioled; flowers numerous, pedicels erect, slightly longer than the subtending leaves; calyx oblong-campanulate, 7–8 mm. long, glandular-pubescent, often dotted with red, in fruit becoming somewhat inflated through the thickening of the ribs and 9–10 mm. long, ribs distinctly corky in mature specimens, teeth equal, triangular-acute, 2 mm. long, spreading, glandular-ciliate; corolla 1.5–2 cm. long, reddish-purple with dark red blotches down each lobe and two broad yellow patches, dotted with red, below the lower lip, tube scarcely exserted, throat broad, funnelform, hairy within, with club-shaped hairs on the ridges, lobes nearly equal, usually emarginate; stamens included, anthers yellow, hispid, filaments glabrous; style sparsely pubescent; stigma reddish-purple, peltate-funnelform, lobes unequal, fimbriate; capsule included, ovate, acute, dehiscent down both sutures, placentae adherent to the apex; seeds oval, favose-areolate.

Distribution: in wet, granite sand in the central Sierra Nevada Mts., from Tuolumne Co. to Mariposa Co., California.

Specimens examined:

California: Hetch-Hetchy Valley, June, 1900, *Bioletti* (Calif. and Calif. Acad., TYPE); abundant in wet places along the roadside, Hetch-Hetchy Valley, 10 June, 1916, *A. L. Grant 807* (G, M, and Calif.); Hog Ranch, above Hetch-Hetchy Valley, 4700 ft. alt., 14 June, 1917, *A. L. Grant 967* (G, Cornell, U. S., M, Calif., and Calif. Acad.); near the saw mill below Hog Ranch, Hetch-Hetchy Valley, 16 June, 1917, *A. L. Grant 995* (M); Hazel Green, Coulterville, Yosemite Road, 5 July, 1896, *Jepson 72m* (Calif.); Malones, Mariposa Co., 30 May, 1883, *Congdon* (G); Malones, 17 May, 1902, *Congdon* (U. S.); Hoeltzel's, Mariposa Co., 3 May, 1893, *Congdon* (Stanford); Stockton Creek, Mariposa Co., 14 June, 1903, *Congdon* (M); Snow Creek, Mariposa Co., 1 June, 1890, *Congdon* (G).

The corky ribs and more acute calyx-lobes immediately separate this species from *M. Palmeri* with which it has been confused. A number of specimens of a white form having two yellow blotches below the lower lip were collected near Hetch-Hetchy Valley by *A. L. Grant*, no. *995*. These grew in two patches with the typical form along the roadside near the saw mill below Hog Ranch, Hetch-Hetchy Valley.

57. **M. Palmeri** Gray in Proc. Am. Acad. **12**: 82. 1876; Syn. Fl. N. Am. 2[1]: 278. 1878, ed. 2, and Suppl. 451. 1886; Greene in Bull. Calif. Acad. Sci. **1**: 121. 1885; Hall in Univ. Calif. Publ. Bot. **1**: 117. 1902; Eastwood, Fl. South Fork King's River, Sierra Club Publ. 27: 67. 1902.

A sparingly glandular-pubescent annual, stem erect, 8–15 cm. high, simple or branched; leaves linear or oblanceolate, 1.3–1.7 cm. long, 2–4 mm. wide, entire or occasionally denticulate, the upper sessile, lower sometimes short-petioled; pedicels slender, much longer than the leaves, more or less spreading in maturity; calyx cylindrical, 7–8 mm. long, slightly angled, reddish, glabrous or minutely puberulent, slightly accrescent and not inflated, 9–10 mm. long when mature, teeth 1–1.5 mm. long, broad, obtuse, mucronate, ciliate; corolla 1.5–2 cm. long, funnelform, tube slightly exserted, throat deep reddish-purple, with a large yellow patch, streaked with red, below the lower lip or more

often with 2 small oblong yellow patches, with scattered club-shaped hairs over the inner surface, lobes erect, nearly equal, rounded, erose or emarginate, reddish-purple with darker red spots at the base or sometimes pink and more or less shaded and marked with yellow; stamens included, filaments glabrous, anthers hairy; style included, stigma-lips equal, broadly rounded; capsule included, oblong, placentae separating at the apex; seeds oblong, favose-areolate.

Distribution: southern Sierra Nevada Mts. and the mountains of southern California.

Specimens examined:

California: Snow Creek, Mariposa Co., 1 June, 1890, *Congdon* (G); Fresno Co., May, 1918, *Kelley* (Cornell); near Milo, Tulare Co., 24 April, 1919, *Goetz 4* (G, N. Y., M, Stanford, Calif., and Calif. Acad.); Milo, 5 April, 1900, *Dudley* (Stanford); fields near Springfield, Tulare Co., 800–1000 ft. alt., 1897, *Purpus 5048* (U. S. and M); near Springfield on Tule River, Tulare Co., 26 March, 1897, *Dudley* (Stanford); Kaweah River Basin, 15 April, 1901, *Hopping 111* (Calif.); Little Bear Valley, San Bernardino Co., 5000 ft. alt., 14 June, 1906, *Parish 5800* (R. Mt.); San Bernardino Mts., 1881, *Parish & Parish* (G); Lytle Creek Canyon, San Antonio Mts., 5800 ft. alt., 1–3 June, 1900, *H. M. Hall 1449* (M and Stanford); Hunsaker Flats, San Bernardino Mts., 8 June, 1919, *Munz & Johnston 2856* (Pomona); San Bernardino Mts., May, 1881, *Parish & Parish 631* (Stanford); southern California, 1876, *Parry & Lemmon 308* (G, Phil., and M); Mohave River, 1 June, 1876, *Edw. Palmer 321½* (G, TYPE, Phil., U. S., and M).

58. **M. filicaulis** Wats. in Proc. Am. Acad. **26**: 125. 1891; Smiley in Univ. Calif. Publ. Bot. **9**: 335. 1921.

A glandular-puberulent annual; stem 4–8 cm. high, erect, simple, fragile; leaves few, spatulate or oblanceolate, 8–9 mm. long, thin, almost transparent, entire, nerveless, pale yellow-green, tapering to a slender base or the lower leaves short-petioled; pedicels filiform, 1–1.5 cm. long, erect, flowers mostly terminal; calyx 6 mm. long, narrowly campanulate, teeth unequal, one smaller than the others, short, triangular-acute, not

ciliate; corolla 1.8–2 cm. long, rose-color, tube yellow, exserted, slender, expanding gradually to a very broad throat and nearly erect, subequal, emarginate lobes, throat yellow, spotted with reddish-purple on the lower side and with two elongated, deep yellow patches below the middle lobe, deep reddish-maroon on the upper side, these colors spreading irregularly over the lobes; stamens and style glabrous, included, anthers hispid, filaments glabrous; stigma reddish-purple, the lobes unequal; capsule not seen.

Distribution: known only from the type locality.

Specimens examined:

California: Snow Creek, Mariposa Co., 1 June, 1890, *Congdon* (G, TYPE).

No confirmation of this species has been made since the type was collected and more material may show that it is a shade form closely related to *M. Palmeri.* These specimens differ from *M. Palmeri* in having unequal non-ciliate calyx-teeth, which are triangular-acute instead of obtuse. The coloring somewhat resembles that of some of the color forms of *M. Palmeri.*

59. **M. gracilipes** Rob. in Proc. Am. Acad. **26**: 176. 1891.

A small glabrous or minutely puberulent annual; stem 6–15 cm. high, slender, simple or irregularly branched; leaves few, lanceolate or linear, 7–9 mm. long, 1–3 mm. wide, entire or denticulate, sessile, usually connivent at the base, basal leaves sometimes obovate; pedicels slender, spreading, 2 or more times the length of the corolla; calyx campanulate, 4–5 mm. long, reddish, not strongly angled, ribs slightly thickened, teeth equal, 1 mm. long, broadly obtuse, mucronate, ciliate; corolla 1–1.5 cm. long, rose-purple, tube yellow, included, very short, throat narrow, cylindrical, exserted, deep maroon, more or less marked with yellow, expanding abruptly to the bilabiate, almost rotately spreading limb, lobes rounded, entire, the upper lip shorter than the lower one; stamens glabrous, included; style glabrous, included, stigma-lips reddish-purple, equal; capsule oblong, obtuse, included, the placentae separating for nearly one-third their length; seeds oval, favose-areolate, slightly apiculate at each end.

Distribution: local in the foothills of Mariposa Co., California.

Specimens examined:

California: Mormon Bar, Mariposa Co., April, 1889, *Congdon* (G, TYPE, and Calif.); Bootjack Ranch, Mariposa Co., April, 1892, *Congdon* (Stanford); cliffs, Mariposa Creek, 19 April, 1903, *Congdon* (M); Mormon Bar, Mariposa Co., 3 May, 1896, *Congdon* (N. Y. and Calif.); Mormon Bar and east, April, 1888 and 1889, *Congdon* (Stanford).

60. **M. androsaceus** Curran ex Greene in Bull. Calif. Acad. Sci. 1: 121. 1885; Jepson, Fl. W. Mid. Calif. 405. 1901, and ed. 2, 378. 1911.

M. Palmeri var. *androsaceus* (Curran) Gray, Syn. Fl. N. Am. ed. 2, 2^1: Suppl. 451. 1886.

A small, nearly glabrous annual; stem 4–10 cm. high, simple or branched; leaves few, sessile, ovate-oblong, 3–5 mm. long, obtuse, entire or obscurely toothed, thick, 1-nerved, the lower leaves with a broad, somewhat cordate-clasping base; pedicels slender, reddish, spreading horizontally, the ends curved upwards, 3–4 times as long as the leaves; calyx reddish, 6–7 mm. long, lightly angled, teeth equal, short, broad, somewhat truncate, mucronate, not ciliate; corolla 8–9 mm. long, deep reddish-purple, tube narrow, included, throat short, funnelform, lobes equal, truncate, little spreading, entire; stamens glabrous, upper pair exserted; style exserted, glabrous, stigma-lips equal; capsule included, broadly ovate, placentae separating at the apex; seeds oval, favose-areolate.

Distribution: in the mountains at Tehachapi, California.

Specimens examined:

California: Tehachapi, May, 1884, *Curran* (Stanford); Tehachapi, June, 1884, *Curran* (G, Phil., Calif., and Stanford, *type collection*).

This species has been generally confused with *M. Palmeri* from which it can be distinguished by its small corolla with equal and entire lobes, its glabrous anthers, its glabrous, nearly truncate calyx-teeth with a mucronate point, and its more spreading and longer pedicels.

61. M. diffusus Grant[1] Pl. 5, fig. 1.

A low diffusely branched annual; stems 7–20 cm. long, minutely puberulent; leaves oblong, ovate or lanceolate, 1–2 cm. long, 3–7 mm. wide, irregularly dentate, sessile, the basal leaves petioled and usually rosulate; pedicels slender, minutely puberulent, 3–5 times as long as the leaves, usually spreading horizontally with the ends curved upwards in mature specimens; calyx oblong-campanulate, 5–7 mm. long, weakly angled, more or less colored with red, the ribs green, frequently tinged and tipped with red, usually thickened, especially at the base, teeth mostly glabrous, short, broadly obtuse, almost truncate, mucronate; corolla 1.3–1.7 cm. long, rose-red, tube slender, exserted, yellow, expanding gradually to the reddish-purple narrowly funnelform throat, often marked with yellow patches or spots, lobes equal, emarginate, little spreading, more or less irregularly marked with reddish-purple or yellow and with club-shaped hairs scattered over the inner surface; stamens included, anthers yellow, glabrous, filaments pubescent, slender, flattened; style pubescent, included, stigma tinged with rose-red, lips equal, rounded, fimbriate; capsule oblong, included, placentae separating at the apex; seeds oval, favose-areolate.

Distribution: arid regions of Riverside Co., and San Diego Co., California, and in Lower California.

Specimens examined:

California: Tahquitz trail near Idyllwild, San Jacinto Mts., 8 July, 1921, *Spencer 362* (Pomona Coll. Herb.); dry hillside, south of Tuscalata Creek, Riverside Co., 30 April, 1922, *Munz 5135* (Pomona); Rice Canyon, Santa Ana Mts., Riverside Co., 24 April, 1923, *Baer* (Pomona); wet sand along stream, Kenworthy, Thomas Valley, San Jacinto Mts., 4800 ft. alt., 20 May, 1922, *Munz & Johnston 5467* (Pomona); Palomar, 29 May, 1901, *Jepson & Hall 1959* (U. S., M, TYPE, and Stanford); meadow at east base of Morgan Hill, Palomar,

[1] **Mimulus diffusus** Grant, sp. nov., annuus; caulibus 7–20 cm. longis, diffusis; foliis oblongis, ovatis lanceolatisve, 1–2 cm. longis, 3–7 mm. latis; pediculis tenuibus, foliis 3–5-plo longioribus; calyce infirme angulato tincto rubro; corolla 1.3–1.7 cm. longa, rosea; antheris glabris, filamentis pubescentibus.—Collected at Palomar, San Diego Co., 29 May, 1901, *W. L. Jepson & H. M. Hall 1959* (U. S. Nat. Herb., Mo. Bot. Gard. Herb., no. 112584, TYPE, and Stanford Univ. Herb.).

San Diego Co., 24 June, 1920, *Pierson* (Pomona); Kootka, Palomar, 17 May–1 June, 1901, *Jepson 1524* (Calif.); Elsinore, 25 April, 1892, *McClatchie 96* (Stanford); Cottonwood Creek, April, 1905, *T. S. Brandegee* (Calif.); vicinity of Santa Ysabel, 25 April, 1893, *Henshaw 100* (U. S.); Witch Creek, San Diego Co., 1 May, 1893, *Henshaw* (G); mountains near Campo, April, 1889, *Orcutt* (U. S.); Cuyamaca Mts., 1880, *Vasey 468* (U. S.); Colorado Desert, San Diego Co., April, 1889, *Orcutt* (M and U. S.).

Mexico:

Lower California: Japa, 5 July, 1884, *Orcutt* (G, N. Y., and Calif.); Guadaloupe Mt., 1 June, 1883, *Orcutt 845* (M).

M. diffusus has been distributed as *M. Palmeri* but it may be recognized by its diffuse branching habit, its long horizontally spreading pedicels, its glabrous calyx-teeth and its pubescent style.

62. **M. purpureus** Grant[1] Pl. 5, fig. 2.

Stem stout, 7–10 cm. high, glandular-pubescent, simple or with a few basal branches; leaves oblong or lanceolate, obtuse, 1–1.5 cm. long, 3–4 mm. wide, sessile, clasping, entire or minutely toothed, indistinctly 3–5-nerved, internodes shorter than the leaves; pedicels 3–5 times as long as the leaves, slender, erect or little spreading, glabrous; calyx glabrous, oblong, 6–7 mm. long, slightly inflated and 7–8 mm. long when mature, teeth equal, broadly obtuse or nearly truncate, mucronate, 1 mm. long; corolla 1.3–1.5 cm. long, reddish-purple, tube narrow, slightly exserted, throat short, funnel-form, lobes unequal, the upper erect, rounded and shorter than the lower spreading, emarginate ones; stamens included, anthers deep reddish-purple, glabrous, filaments pubescent; style pubescent, stigma-lobes rounded, equal, fimbriate; capsule oblong, included, dehiscent to the base along both sutures, placentae separated at the apex; seeds oval, reticulate.

[1] **Mimulus purpureus** Grant, sp. nov., caules crassi, 7–10 cm. longi, glanduloso-pubescentes, plerumque simplices; foliis oblongis lanceolatisve, obtusis, 1–1.5 cm. longis, sessilibus, internodiis foliis brevioribus; calyce 6–7 mm. longo; corolla 1.3–1.5 cm. longa, purpureo-rubra, laciniis inaequalibus; antheris glabris, filamentis styloque pubescentibus.—Collected in Bear Valley, San Bernardino Mts., June, 1886, *S. B. & W. F. Parish 1862* (Stanford Univ. Herb. no. 74177, TYPE).

Distribution: known only from southern California.

Specimens examined:

California: Bear Valley, San Bernardino Mts., June, 1886, *Parish & Parish 1862* (Stanford, TYPE); Bear Valley, San Bernardino Mts., 6800 ft. alt., 10 June, 1922, *Munz 5651* (Pomona); Grant Creek, San Bernardino Mts., 3 June, 1901, *Parish 4903* (Stanford); dry ground near Lake, Big Bear Valley, San Bernardino Mts., 6500 ft. alt., 4 July, 1920, *Harwood 4349* (Pomona); San Jacinto, 1892, *Gregory* (Calif.).

This species has been confused with *M. Palmeri* from which it may be separated by its short leafy stems, its short internodes, and the numerous very long, erect pedicels.

62a. Var. **pauxillus** Grant[1]

Plants much smaller than the species and less branched, the stems 1–3 cm. long; pedicels mostly erect, usually longer than the rest of the plant; calyx 3–4 mm. long, campanulate, not angled, more strikingly colored red and green than in the species, teeth with a scarious margin, rarely mucronate; corolla 1–1.4 cm. long, more or less spotted and tinged with yellow, the tube very slender.

Distribution: known only from the type locality.

Specimens examined:

Mexico:

Lower California: San Pedro Martir, 15 May, 1893, *T. S. Brandegee* (G, TYPE, and U. S.).

The dwarf size of this variety and the color of the calyx distinguish it from any closely related species.

63. M. exiguus Gray in Proc. Am. Acad. **20**: 307. 1885; Syn. Fl. N. Am. ed. 2, **2**[1]: Suppl. 451. 1886; Greene in Bull. Calif. Acad. Sci. **1**: 122. 1885; Conzatti & Smith, Fl. Sin. Mex. 117. 1897.

A low glabrous annual with very slender, erect, reddish stems, 3–10 cm. high, simple or more often diffusely branched; leaves

[1] **Mimulus purpureus** var. **pauxillus** Grant, var. nov., herbae minores; caulibus 1–3 cm. longis; pediculis plerumque caulibus longioribus; calyce 3–4 mm. longo, non angulato; corolla 1–1.4 cm. longa.—Collected at San Pedro Martir, Lower California, 15 May, 1893, *T. S. Brandegee* (Gray Herb., TYPE, and U. S. Nat. Herb.).

few, linear or spatulate, 3–5 mm. long, 1–2 mm. broad, entire or obscurely denticulate; flowers minute, numerous, appearing from near the base; pedicels elongated, filiform, spreading, 3 to 4 times as long as the leaf; calyx campanulate, glabrous, 2 mm. long, very weakly angled, scarcely sulcate, much distended by the capsule in fruit and completely filled by it, teeth equal, ovate, acute, about one-third as long as the calyx; corolla funnelform, 3 mm. long, pink to rose-red, little exserted, lobes equal, short, erect, rounded, emarginate; stamens exserted, the upper pair almost as long as the corolla, glabrous; style and stigma exserted, glabrous, often slightly longer than the corolla, stigma deep pink, infundibuliform, lobes unequal, oblong; capsule ovate, acute, longer than the calyx, placentae separating at apex; seeds oval, apiculate at both ends, faintly reticulate.

Distribution: mountains of southern California and Lower California.

Specimens examined:

California: Bear Valley, San Bernardino Mts., 6000 ft. alt., June, 1886, *Parish 1852* (Stanford).

Mexico:

Lower California: Hansen's Ranch, northern Lower California, 6000 ft. alt., 9 July, 1884, *Orcutt 1198* (G, TYPE, M, and Calif.); mountains, northern Lower California, 5 July, 1884, *Orcutt* (Calif.).

64. M. discolor Grant[1]

Dwarf glandular-pubescent plants, the simple or branched stems 3–12 cm. long, very slender; leaves in few pairs, sessile, linear or spatulate, .3–1.5 cm. long, 1–2 mm. wide, obtuse, entire; pedicels filiform, mostly longer than the leaves, often deflexed when mature; calyx campanulate, 4–9 mm. long, tinged with red

[1] **Mimulus discolor** Grant, sp. nov., herbae annuae nanae; caule 3–12 cm. longo, glanduloso-pubescente; foliis linearibus spatulatisve, obtusis, sessilibus, integerrimis; pediculis tenuibus; calyce infirme angulato, dentibus late triangulari-acutis; corolla 1.2–2 cm. longa, plerumque flava, plus minusve rubro tincta maculosave, aliquando rubro-purpurea, tubo tenui, exserto; staminibus inclusis, antheris hispidis; stylo exserto, stigmae laciniis inaequalibus.—Collected on gravelly slopes of Pah Ute Peak, southeastern California, 7000–8000 ft. alt., April–September, 1897, *C. A. Purpus 5311* (U. S. Nat. Herb., and Mo. Bot. Gard. Herb. no. 106746, TYPE).

or maculate, weakly angled, teeth equal or subequal, broadly deltoid, acute, 1 mm. long, margins hispid; corolla 1.2–2 cm. long, mostly yellow, more or less tinged or dotted and lined with red or occasionally deep reddish-purple, tube slender, exserted, throat ampliate, funnelform, orifice densely bearded with short club-shaped hairs, two bands of them continuing down the throat on the lower side, upper lobes rounded, usually entire, lower lobes longer, somewhat spreading, entire or emarginate; stamens included, anthers sparingly hispid, filaments pubescent; style glabrous, exserted, stigma-lips unequal, broadly rounded; capsule included, oblong, placentae tardily separating at the apex; seeds oval.

Distribution: open places in the Upper Transition and Canadian zones of the central Sierra Nevada Mts., California.

Specimens examined:

California: trail to Belle Meadow, Tuolumne Co., 12 July, 1915, *Jepson 6489b* (Calif.); Wawona, Mariposa Co., 4300 ft. alt., 1 July, 1911, *Jepson 4310* (Cornell); Home Camp Creek, Huntington Lake, Fresno Co., 18 July, 1918, *A. L. Grant 1421a* (Cornell); trail to Nellie Lake, Fresno Co., 8000 ft. alt., 11 July, 1917, *A. L. Grant 1080* (M and Calif.); Huntington Lake, 5 July, 1917, *A. L. Grant 1024* (Cornell, M, Calif., Stanford, and Pomona); in sandy spots, Pittman Creek above Huntington Lake, 8000 ft. alt., 27 July, 1918, *A. L. Grant 1480* (Cornell, M, and Calif.); Sequoia National Park, July, 1908, *Davidson 1975* (Davidson); General Grant National Park, 10 June, 1921, *Ottley 1455* (Cornell and M); Markwood Meadows, Pine Ridge, Fresno Co., 5900 ft. alt., 15–25 June, 1900, *Hall & Chandler 339* (M and Calif.); near Brown Meadows, Tulare Co., 7000 ft. alt., 18 June, 1904, *Hall & Chandler 5155b, 5155c* (Calif.); plateau country about Mt. Silliman, 7000 ft. alt., 3–4 July, 1900, *Jepson 717* (Calif.); gravelly slopes, Pah Ute Peak, 7000–8000 ft. alt., April-Sept., *Purpus 5311* (M, TYPE, and U. S.); Greenhorn Range, Kern Co., 6000 ft. alt., 2–10 June, 1904, *Hall & Babcock 5050* (Calif.); Kernville, 13 May, 1891, *T. S. Brandegee* (Calif.).

65. M. montioides Gray in Proc. Am. Acad. 7: 380. 1867,

mainly; Syn. Fl. N. Am. ed. 2, 2[1]: Suppl. 450. 1886; Greene in Bull. Calif. Acad. Sci. 1: 115. 1885; Smiley in Univ. Calif. Publ. Bot. 9: 337. 1921.

M. rubellus var. *latiflorus* Wats. in Bot. King's Exp. 225. 1871; Gray in Bot. Calif. 1: 568. 1876; Syn. Fl. N. Am. 2[1]: 278. 1878, and ed. 2, 1886.

M. rubellus Gray in Proc. Am. Acad. 11: 99. 1876, as to size of corolla; Bot. Calif. 1: 568. 1876, as to size of corolla.

Plant glandular-pubescent or finely viscid-puberulent; stems 1–8 cm. high, simple and erect or more often branched somewhat freely from the base; leaves linear to linear-lanceolate, 1.2–2.5 cm. long, 2–6 mm. wide, sessile by a broad base, the lower leaves spatulate, lanceolate, obtuse, usually sessile, 1–3-nerved, entire; flowers mostly numerous and flowering from near the base, pedicels slender, .5–2.5 cm. long, spreading little when mature; calyx narrowly tubular, 5–6 mm. long, more or less tinged with red, teeth equal, short, usually less than 1 mm. long, broadly ovate, rounded at the apex and mucronate, ciliate; corolla 1–1.8 cm. long, yellow, often tinged or spotted with red, tube slender, exserted about one-half its length, expanding abruptly to a short, funnelform throat and spreading bilabiate limb, bearded on the lower side, limb 1–1.7 cm. in diameter, the margins rounded, often undulate; upper pair of stamens slightly longer than the throat, the filaments sparsely glandular-pubescent above, anthers glabrous; style exserted, the stigma broadly peltate-funnelform, lobes obovate, equal; capsule included, oval, compressed, acute, placentae separating for nearly half their length; seeds oval, about 1½ times as long as broad, reticulate.

Distribution: moist places in Nevada and in the high southern Sierra Nevada Mts., California.

Specimens examined:

Nevada: moist places near Carson City, March–May, 1863, *Anderson 73* (G); near Carson City, 5000 ft. alt., Apr., 1865, *Watson 790* (G); near Carson City, 1865, *Anderson* (G, N. Y., and U. S.).

California: high southern Sierras, collection of 1864, *Brewer "2785 with"* (G, TYPE, and U. S.).

66. M. deflexus Wats. in Proc. Am. Acad. **24:** 84. 1889; Coville, Contr. U. S. Nat. Herb. **4:** 171. 1893.

M. barbatus Greene in Bull. Calif. Acad. Sci. **1:** 9. 1884.

Dwarf, sparsely puberulent annuals; stem 3–8 cm. high, erect, simple or sometimes closely branched; leaves few, sessile, oblanceolate or linear, 4–17 mm. long, 1–2 mm. wide, obtuse, more or less glandular-pubescent, the basal leaves spatulate and short-petioled; pedicels filiform, at least twice as long as the leaves, often enlarged at the base and spreading horizontally in mature specimens; calyx minutely glandular-puberulent, 4 mm. long, oblong-campanulate, reddish, the ribs more or less thickened and sometimes colored red or yellow, 5 mm. long in fruit, slightly distended by the mature capsule, teeth ovate, rounded, one-fourth as long as the calyx, obtuse, mucronate, or sometimes longer and acute; corolla bilabiate, 1–1.5 cm. long, slender, tubular-funnelform, tube yellow, twice as long as the calyx, throat short and broad, with long hairs scattered over the inner surface, lobes unequal, narrow, bifid or deeply emarginate, the upper lip deep reddish-purple, erect, usually longer than the spreading lower lip, the latter yellow and more or less spotted or streaked with red or the corolla occasionally yellow streaked with red; stamens flattened, the longer pair slightly exserted, sometimes with pubescent filaments, anthers glabrous; style glabrous, yellow, exserted, stigma-lips unequal, rounded, fimbriate; capsule oblong, included, placentae separating nearly to the middle; seeds favose-areolate, about as long as broad.

Distribution: in granite sand around meadows in the high Sierra Nevada Mts., Tulare Co., California.

Specimens examined:

California: drier edges of low wet places in Long Meadow, Tulare Co., June, 1886, *Edw. Palmer 176* (G, TYPE, and M); in sandy soil around meadow, Long Meadow, Tulare Co., 14 June, 1904, *Hall & Babcock 5107* (G, M, R. Mt., Ore., Stanford, and Pomona); near Brown Meadow, Tulare Co., 7000 ft. alt., 18 June, 1904, *Hall & Babcock 5155* (G, Calif., and Stanford); Templeton Mt., near Kern Peak, 8700 ft. alt., 5 July, 1912, *Jepson 4968* (Cornell and Calif.); Rock Creek near Mt. Whitney, 9600 ft. alt., 20 July, 1912, *Jepson 5038* (Calif.); Cotton-

wood Creek, 10500 ft. alt., 23 July, 1912, *Jepson 5058* (M and Calif.); Cannell Meadows, southeastern Tulare Co., 7000 ft. alt., 15 June, 1904, *Hall & Babcock 5113, 5113b* and *5113c* (Calif.); sandy places, Whitney Meadows, 9000–11000 ft. alt., Aug., 1895, *Purpus 1372* (Calif.).

A variable species, presenting interesting color forms. It is related to *M. montioides* but can be separated from that species by its general habit and by its narrow corolla-lobes which are deeply emarginate, the upper lip erect and the lower spreading.

67. **M. Breweri** (Greene) Coville, Contr. U. S. Nat. Herb. **4**: 171. 1893; Hall, Yosemite Fl. 223. 1912; Piper & Beattie, Fl. Northwest Coast, 324. 1915; Rydberg, Fl. Rocky Mountains, 780. 1917. Pl. 9, fig. 1.

Eunanus Breweri Greene in Bull. Calif. Acad. Sci. **1**: 101. 1885; Howell, Fl. Northwest Am. 519. 1903.

Mimulus rubellus Gray in Bot. Calif. **1**: 568. 1876, in part; Syn. Fl. N. Am. 2^1: 278. 1878, ed. 2, and Suppl. 451. 1886, as far as the description is drawn from a "viscid puberulent" plant.

Stem 2–15 cm. high, simple or with numerous ascending branches, the whole plant glandular-puberulent or pubescent; leaves oblong or linear, 1–2 cm. long, 1–4 mm. wide, obtuse, entire or indistinctly toothed, tapering to a short, slender petiole or more often sessile, 1-nerved; flowers numerous, pedicels slender, 2–10 mm. long, usually longer than the calyx; calyx cylindrical, slightly spreading at the top, 4–8 mm. long, often reddish or spotted with red, more or less distended by the mature capsule or sometimes with ribs slightly corky when mature, teeth nearly equal or the upper tooth somewhat longer, 1–2 mm. long, broadly triangular-acute; corolla funnelform, 6–10 mm. long, pale pink to rose-red or red, glabrous externally, little exceeding the calyx, tube mostly included, throat short, with few scattered hairs, sometimes with 2 yellow lines below the lower lip, spreading slightly, the lobes subequal, entire or emarginate, often with a red spot near the base of each; stamens exserted, unequal, not approximate, glabrous; style glabrous, nearly as long as the upper pair of stamens, or occasionally included and shorter than the

stamens, stigma-lips unequal, funnelform, the upper lip spatulate, rounded, the lower truncate, less than one-half as long as the upper; capsule about as long as the calyx, oblong, acute, the placentae separating at the apex but firmly adherent below; seeds about twice as long as broad, apiculate, reticulate.

Distribution: growing mostly in sandy soil along the edges of damp places or where water has been standing but has evaporated. Common from Idaho to British Columbia and down the coast into southern California.

Specimens examined:

Wyoming: Lewis River, Yellowstone Nat'l. Park, 9 Aug., 1899, *Nelson & Nelson 6371* (R. Mt.).

Idaho: damp loamy swales, Silver City, Owyhee Co., 7000 ft. alt., 15 July, 1910, *Macbride 404* (M and R. Mt.); ridges south from Wiesner's Peak, 26 July, 1895, *Leiberg 1365* (M); moist earth patch on granitic rock, Sawtooth Peaks, Blaine Co., 9 August, 1916, *Macbride & Payson 3703* (R. Mt.).

British Columbia: west of Sophie Mt., near International Boundary between Kettle and Columbia Rivers, 5000 ft. alt., 10 July, 1902, *Macoun 67855* (Cornell, M, and Pomona).

Washington: Mt. Rainier, 1906, *Carpenter 53* (M); on damp rocks, Mt. Paddo, 6000–7000 ft. alt., 28 June, 1885, *Suksdorf* (M).

Nevada: head of Fall Creek, Ormsby Co., 21 Aug., 1902, *C. F. Baker 1510* (Pomona).

Oregon: in Union Co., 1884, *Cusick* (G).

California: Shackleford Creek, Upper Campbell Lake, Siskiyou Co., 4000 ft. alt., 9 July, 1910, *Butler 1733* (R. Mt. and Stanford); northeastern Shasta Co., 4300 ft. alt., June, 1903, *Hall & Babcock 4154* (R. Mt.); 6 miles below Bartlett, McCloud River, June–Aug., 1893, *M. S. Baker* (M and Calif.); Red Clover Valley, Plumas Co., 6 July, 1907, *Heller & Kennedy 8753* (M and Stanford); Chico Meadows, Butte Co., 4000 ft. alt., 22 June, 1914, *Heller 11495* (M, Ore., and Stanford); near Donner Lake, 1865, *Torrey 373* (G); Wood's Peak, borders of the Lake, 9000–10000 ft. alt., 1863, *Brewer 2114* (G, *type collection*); Summit, Nevada Co., July, 1898, *Jepson 67m* (Calif.); Truckee, Nevada Co., July, 1893, *Sonne* (M); lower end of Donner Lake, Nevada Co., 10 July, 1903, *Heller 6893*

(M, R. Mt., Stanford, and Pomona); Donner Lake, Aug., 1883, *Greene* (G and M); Lake Valley, Lake Tahoe Region, 6400 ft. alt., 27 July, 1911, *Abrams 4780* (Stanford); Tahoe Tavern, Lake Tahoe, 6200 ft. alt., 15 July, 1906, *G. B. Grant 6946* (Stanford); Cisco, Placer Co., 5400 ft. alt., 22 June, 1910, *H. M. Hall 8704* (M, R. Mt., Stanford, and Pomona); Silver Lake, Amador Co., 8000 ft. alt., July, 1892, *Hansen 441* (M and Stanford); near Columbia, Tuolumne Co., 2000 ft. alt., 14 May, 1915, *A. L. Grant 41* (M, Calif., and Stanford); Strawberry Lake, Tuolumne Co., 5500 ft. alt., 10 June, 1917, *A. L. Grant 955* (G, M, Ore., Calif., and Pomona); McGill's, Hetch-Hetchy Valley to Lake Eleanor, Tuolumne Co., 12 July, 1894, *Burnham* (Cornell); Hog Ranch, above Hetch-Hetchy Valley, 16 June, 1917, *A. L. Grant 996* (G, N. Y., Cornell, U. S., M, and Calif.); Yosemite Falls, 5000 ft. alt., 25 June, 1911, *Jepson 4273* (Calif.); sandy soil, Yosemite, 1866, *Bolander 6311* (G); Jackass Meadow, Madera Co., 7000 ft. alt., 25 July, 1918, *A. L. Grant 1335* (Cornell, M, and Calif.); Huntington Lake, Fresno Co., 7000 ft. alt., 5 July, 1917, *A. L. Grant 1033* (G, N. Y., U. S., M, and Calif.); trail to Dinkey Grove of Big Trees, Fresno Co., 29 July, 1917, *A. L. Grant 1178* (M, N. Y., Phil., and Calif.); Rowell Meadows, Upper King's River, Fresno Co., 23 Aug., 1904, *Dudley* (Stanford); Pine Ridge, Fresno Co., 15–25 June, 1900, *Hall & Chandler 321* (M and Stanford); near Mt. Silliman, Tulare Co., 7000 ft. alt., 3–4 July, 1900, *Jepson 740* (Calif.); region of Kaweah Peaks, Kern-Kaweah Falls, Tulare Co., 10000 ft. alt., 31 July, 1897, *Dudley 2364* (Stanford); in the "Horse Pasture" near the summit of Mt. Sanhedrin, Lake Co., 20 July, 1902, *Heller 5927* (M, R. Mt., and Pomona); Webber Lake, 8 July, 1901, *Kennedy & Doten 121* (R. Mt.); moist fine-gravelly hillslopes, Trinity Summit, Humboldt Co., 7000 ft. alt., 16–23 July, 1902, *Jepson 2108* (Calif.); South Yollo Bolley Mts., 9600 ft. alt., 24 July, 1897, *Jepson 54m* (Calif.); Cottonwood Creek, Inyo Co., 10000 ft. alt., 23 July, 1912, *Jepson 5072* (Calif.); Tahquitz Valley, San Jacinto Mts., 8000 ft. alt., July, 1901, *H. M. Hall 2346* (Stanford); Bluff Lake, San Bernardino Mts., 7400 ft. alt., 20 June, 1894, *Parish 2962* (U. S. and M); San

Bernardino Co., 1876, *Parry & Lemmon 312* (G and M); north side of San Bernardino Mts., May, 1882, *Parish & Parish 1719* (M and Stanford); marshy soil, Hunsaker Flats, San Bernardino Mts., 5200 ft. alt., 8 June, 1919, *Munz & Johnston 2850* (Pomona); damp soil by creek, Fish Camp, San Bernardino Mts., 17 July, 1921, *I. M. Johnston 2900* (Pomona).

This species has been generally confused with *M. rubellus* to which it is closely related. It differs from that species, principally, in being glandular-pubescent or glandular-puberulent, in the shape of the calyx-teeth, and in the placentae being firmly adherent for most of their length. The pedicels are usually longer than the calyx, but all gradations occur from those with pedicels much shorter than the calyx to those nearly twice as long. Corky calyx-ribs are found in the specimens of *A. L. Grant 1033* from Huntington Lake, Fresno Co., California.

68. **M. Suksdorfii** Gray, Syn. Fl. N. Am. ed. 2, 2[1]: Suppl. 450. 1886; Howell, Fl. Northwest Am. 522. 1903; Rydberg, Fl. Rocky Mountains, 780. 1917.

M. montioides Gray in Proc. Am. Acad. 7: 380. 1867, as to the form "corolla parva calyce paullo longiore."

Stems short, 2–7 cm. high, usually freely branched from the base, the plant sparsely viscid-puberulent and more or less tinged with red; leaves oblong, oblanceolate or linear, 5–12 mm. long, 1–2 mm. wide, obtuse, entire or irregularly sinuately toothed, tapering below to a sessile base or the lower sometimes petioled, flowers numerous, the pedicels slender, 5–7 mm. long, ascending; calyx cylindrical, 4–6 mm. long, reddish, teeth less than 1 mm. long, mostly equal, broadly ovate, rounded, apex sharply toothed or mucronate; corolla funnelform, 5–6 mm. long, yellow, throat barely exserted, sparsely bearded within, lobes emarginate, equal or nearly so; style and stamens glabrous, slightly longer than the throat, stigma-lips unequal; capsule barely included, oval, acute, compressed, the placentae separating about one-third of their length; seeds oval, twice as long as broad, striately ribbed.

Distribution: gravelly moist places in the high mountains from Wyoming and Idaho to Arizona, west to Washington and southern California.

Specimens examined:

Montana: Alta, 26 July, 1909, *Jones* (Pomona).

Wyoming: Swan Lake, 7400 ft. alt., June, 1885, *Tweedy 577* (Stanford); Centennial Hills, 9 June, 1895, *Nelson 1287* (R. Mt.).

Colorado: Sulphur Springs, Grand Co., 10 June, 1906, *Osterhout 3261* (G and R. Mt.); Middle Park, 1864, *Parry* (G and M).

Idaho: Shoshone, 27 May, 1899, *Trelease & Saunders 4890* (M); New Plymouth, Canyon Co., 24 April, 1911, *Macbride 775* (G and R. Mt.).

Utah: Antelope Island, 5000 ft. alt., June, 1869, *Watson 797* (G and U. S.).

Arizona: N. Arizona, 1884, *Lemmon 3270* (G).

Nevada: Eagle Valley, Ormsby Co., 7 June, 1902, *C. F. Baker 1029* (G, U. S., M, and Pomona); Peavine Mt., Washoe Co., 2 June, 1909, *Heller 9733* (Stanford); near Empire City, 1865, *Torrey 379* (G and U. S.).

Washington: on rocks, Mt. Paddo, 7000–8000 ft. alt., 29 June, 1885, *Suksdorf 487* (G, TYPE, and Calif.); on rocks, Mt. Paddo, 7000–8000 ft. alt., 12 July, 1886, *Suksdorf 893* (Phil. and M); in gravelly soil made up of sand and decomposed basalt, Grant Orchards, 1915, *Evans & Hammond* (Ore.).

Oregon: Ontario, Mathew Co., 6 May, 1898, *Leiberg 2018* (G); near camp, Dry Run, Crook Co., 28 June, 1894, *Leiberg 348* (G); basaltic hills near Harper Ranch, Mathew Co., 20 May, 1896, *Leiberg 2076* (G and U. S.).

California: between Vinton and Beckwith, Plumas Co., 2 July, 1907, *Heller & Kennedy 8688* (G and M); Chat, Lassen Co., 5000 ft. alt., 19 June, 1897, *Jones* (U. S.); Mono Pass, Sept., 1866, *Bolander 6316* (G and U. S.); North Fork Crooked Creek, White Mts., 10200 ft. alt., *Jepson 7262* (Phil., Cornell, M, and Calif.); summit of Grapevine Peak, east of Death Valley, Inyo Co., 8000 ft. alt., 12 June, 1891, *Coville & Funston 1768* (U. S.); Cottonwood Creek, Inyo Co., 10000 ft. alt., 23 July, 1912, *Jepson 5070* (Calif.); Bear Valley, San Bernardino Mts., 6000 ft. alt., June, 1886, *Parish 1851* (Stanford); Bear Valley, San Bernardino Mts., June, 1892, *Parish* (Calif.); common in low moist ground, Bear Valley, San Bernardino Mts., 10 June,

1922, *Munz 5657* (Pomona); Tahquitz Valley, San Jacinto Mts., 6 July, 1922, *Munz 5995* (Pomona).

M. Suksdorfii is a small, usually compact, much-branched annual with numerous flowers close together, differing in these characters from *M. rubellus* with which it is most easily confused. *M. rubellus* is usually a taller plant, with few branches and with larger flowers scattered along the stems. Dr. Gray separated the two species mainly on corolla characters, but these do not hold. *M. Suksdorfii* has all of the corolla-lobes notched, but *M. rubellus* varies in this respect, all of the lobes being emarginate or only those of the upper or of the lower lip. The ciliate calyx-teeth of *M. rubellus* have also been used as a distinguishing character, but this is not constant, either. The usually low, compact, bushy habit, together with the generally smaller calyx and corolla and the unequal stigma-lobes of *M. Suksdorfii*, seem to be the best way of separating the two species.

69. **M. rubellus** Gray ex Torr. Bot. Mex. Bound. 116. 1859; Proc. Am. Acad. **11**: 99. 1876, in part; Syn. Fl. N. Am. **2**[1]: 278. 1878, ed. 2, and Suppl. 451. 1886, in part; Bot. Calif. **1**: 568. 1876, in part; Greene in Bull. Calif. Acad. Sci. **1**: 116. 1885; Wooton & Standley, Contr. U. S. Nat. Herb. **19**: 587. 1915; Howell, Fl. Northwest Am. 522. 1903; Nelson in Coulter & Nelson, Manual Cent. Rocky Mountains, 453. 1909; Jepson, Fl. W. Mid. Calif. 403. 1901, and ed. 2, 378. 1911; Rydberg, Fl. Rocky Mountains, 780. 1917.

M. gratioloides Rydb. in Bull. Torr. Bot. Club **28**: 27. 1901; Fl. Rocky Mountains, 780. 1917.

Stem 3–20 cm. high, erect, simple or branched from the base, the whole plant glandular-puberulent to almost glabrous, usually more or less reddish in color; leaves oblong to lanceolate or linear, obtuse, .7–1.7 cm. long, 2–5 mm. broad, narrowed to a sessile base, the lowest leaves occasionally petiolate, 1–3-nerved, the margins entire or irregularly toothed; flowers scattered, the pedicels slender, 1–2 cm. long, spreading; calyx tubular, 4–9 mm. long, 1.5–2.5 mm. broad, teeth short, rarely over 1 mm. long, usually ciliate, equal, broadly ovate, rounded, mucronate, giving the calyx a more or less truncate appearance, the ribs and often

the whole calyx colored red; corolla 6–10 mm. long, red or yellow, rarely white, or the tube and throat yellow and the lobes tinged with pink, tube slender, expanding gradually to a short, somewhat exserted funnelform throat, lobes rounded, little spreading, subequal, emarginate or sometimes entire, or those of the upper lip or of the lower lip entire and the others emarginate; style and stamens glabrous and about as long as the throat, stigma-lobes equal, oblong, rounded; capsule oblong, slightly shorter than the calyx, placentae separated about one-third their length; seeds oval, twice as long as broad, striately ribbed.

Distribution: throughout the mountainous districts in the Rocky Mountain and Pacific Coast states.

Specimens examined:

Wyoming: under sage brush, Indian Creek, Carbon Co., 25 June, 1901, *Goodding 99* (R. Mt.); Swan Lake, Yellowstone Park, 7400 ft. alt., June, 1885, *Tweedy 875* (Stanford).

Colorado: Butte, 5 miles southwest of LaVeta, 22 May, 1900, *Rydberg & Vreeland 5660* (R. Mt.); Crystal Creek, 8000 ft. alt., 27 June, 1901, *C. F. Baker 253* (G, U. S., M, R. Mt., and Pomona); sage-brush flat, Naturita, 5500 ft. alt., 21 May, 1914, *Payson 331* (G, M, and R. Mt.); Gore Cañon, Grand Co., 24 June, 1907, *Osterhout 3508* (R. Mt.).

New Mexico: wet ravines, Organ Mts., April, *Bigelow* (G, TYPE); 1 mile west of Hillsboro, Sierra Co., 5500 ft. alt., 1 May, 1904, *Metcalfe 1536* (M); Organ Mts., Dona Ana Co., 16 April, 1893, *Wooton* (R. Mt.); copper mines, April, 1852, *Wright 1483* (G, Phil., and M); in the Hueco Mts., Mar., 1851, *Thurber 135* (G).

Utah: near Osmer, southern Utah, 1874, *Siler 70* (M); Milford, 10 May, 1903, *Stokes* (Calif.).

Arizona: fenced area, Santa Rita Forest Reserve, 20–23 Apr., 1903, *Griffiths 4183* (M); by streams of the Santa Catalina Mts., 19 April, 1881, *Pringle* (G and Phil.); San Francisco Mts., May–Oct., 1900, *Purpus 7069* (Calif.); Colorado River Valley, Mar., 1876, *Edw. Palmer 632* (U. S. and M); Stone Cabin Cañon, Santa Rita Mts., 4800 ft. alt., 17 April, 1903, *Thornber 378* (U. S., M, and Stanford); Ash Fork, 12 May, 1883, *Rusby 764* (U. S. and Calif.); vicinity of Flagstaff, 1 June, 1898, *MacDougal 15* (R. Mt.).

Nevada: Reno, June, 1884, *Curran* (G); dry woods, 7 miles east of Ely, 13 Aug., 1913, *Hitchcock 1256* or *1257* (U. S.); near Verdi, Washoe Co., 5300 ft. alt., 30 June, 1913, *Heller 10889* (M and Stanford); Mormon Mts., Clark Co., 24 May, 1906, *Kennedy & Goodding 86* (Stanford); Clover Mts., April, 1888, *Watson 797* (U. S.).

California: Lake Co., May, 1884, *Curran* (G); Silver Canyon in the White Mts., east of Laws, 9 May, 1906, *Heller 8210, 8212* (U. S., M, and Stanford); Surprise Cañon, Panamint Mts., 15 April, 1891, *Coville & Funston 637* (U. S.); near Mineral King, Death Valley Expedition, 7 Aug., 1891, *Coville & Funston 1524* (U. S.); north side of San Bernardino Mts., May, 1882, *Parish & Parish 1378* (Stanford); Lytle Creek Canyon, San Antonio Mts., 6000 ft. alt., 1–3 June, 1900, *H. M. Hall 1458* (M and Stanford); Smith Water Canyon, Quail Springs, Little San Bernardino Mts., 3200 ft. alt., 7 May, 1922, *Munz & Johnston 5217* (Pomona); Santa Rosa, Riverside Co., 30 June, 1922, *Munz 5911* (Pomona).

Subgenus II. Schizoplacus Grant

Subgenus II. Schizoplacus Grant, new subgenus

Shrubs or annuals, viscid or glandular-pubescent, pilose, or with a glutinous exudation; pedicels shorter than the calyx; corolla bilabiate or with nearly equal lobes; anthers commonly approximate in pairs forming a cross and frequently connivent, filaments glabrous or puberulent, mostly included; style glandular-pubescent on upper half or along the whole length; stigma bilamellate or peltate-funnelform, lips equal or unequal; capsule membranaceous or coriaceous, included or exserted, dehiscent along the inner suture, and part way or not at all along the outer suture, rarely indehiscent; placentae separating completely and adherent to the valves. Sect. 5–10.

Section 5. Eunanus Gray

§ 5. Eunanus Gray in Bot. Calif. **1**: 564. 1876; Proc. Am. Acad. **11**: 95. 1876; Syn. Fl. N. Am. **2**^{1}: 273. 1878, ed. 2, and Suppl. 444. 1886; Wettst. in Engl. & Prantl, Nat. Pflanzenfam. **4**^{3b}: 71. 1891.

Eunanus Benth. in DC. Prodr. **10**: 374. 1846; Watson in Bot. King's Exp. 226. 1871; Gray in Proc. Am. Acad. **7**: 381. 1876; Greene in Bull. Calif. Acad. Sci. **1**: 96. 1885, in part; Manual Bay Region, 275. 1894; Howell, Fl. Northwest Am. 518. 1901; Conzatti & Smith, Fl. Sin. Mex. 117. 1897.

Glandular or viscid-pubescent annuals; pedicels shorter than the tubular or campanulate calyx; corolla tubular-funnelform or campanulate, sometimes bilabiate, reddish-purple, occasionally pink, red, or yellow, often withering persistent, lobes nearly equal or unequal, tube less than twice the length of the calyx; style glandular-pubescent, stigma-lips equal or unequal; capsule membranaceous, separating to the base along the inner suture and about half way down the outer, occasionally opening to the base along both sutures, placentae dividing completely and adherent to the valves. Sp. 70–93.

Key to the Species

A. Mature calyx distinctly inflated.
- a. Corolla manifestly bilabiate.
  - α. Calyx-throat oblique, teeth unequal.
    - I. Corolla-tube included.
      - 1. Corolla-throat ventricose.
        - * Corolla broadly campanulate, limb 2–4 cm. wide, yellow .... *70. M. brevipes*
        - ** Corolla-throat broad, cylindrical, limb less than 2 cm. wide, pink or deep reddish-purple .... *71. M. Bolanderi*
      - 2. Corolla funnelform, throat not ventricose .... *72. M. Parryi*
    - II. Corolla-tube exserted.
      - 1. Calyx-teeth mostly blunt .... *81. M. Torreyi*
      - 2. Calyx-teeth triangular-acute or lanceolate.
        - * Plants mostly glandular-puberulent; anthers hispid .. *84. M. Austinae*
        - ** Plants glandular-pubescent; anthers glabrous .. *86. M. angustifolius*
  - β. Calyx-throat slightly if at all oblique, teeth nearly equal.
    - I. Mature calyx tubular-campanulate; pedicels 2–3 mm. long; capsule ovate, obtuse .... *83. M. nanus*
    - II. Mature calyx flaring abruptly to a wide-open throat; pedicels 3–7 mm. long; capsule linear-lanceolate .... *85. M. clivicola*
- b. Corolla not bilabiate, the lobes equal or nearly so.
  - α. Corolla little exserted, less than 1½ times as long as the calyx.
    - I. Capsule exserted .... *80. M. Rattani*
    - II. Capsule included .... *79. M. decurtatus*
  - β. Corolla more than 1½ times as long as the calyx.
    - I. Corolla-tube at least 1¾ times as long as the calyx.
      - 1. Anthers hispid; leaves narrowly oblong or linear ...... *82. M. Layneae*
      - 2. Anthers glabrous; leaves broadly obovate .... *73. M. spissus*

II. Corolla-tube less than 1¾ times as long as the calyx.
1. Corolla-throat ventricose .... *78. M. subsecundus*
2. Corolla-throat not ventricose.
* Calyx-teeth broadly triangular, equal or nearly so. . *77. M. Fremontii*
** Calyx-teeth subulate, unequal.
† Corolla mostly more than 1.5 cm. long.
‡ Leaves usually sessile; style slightly exserted. . *76. M. Cusickii*
‡‡ Leaves usually short-petioled; style included. . *74. M. Bigelovii*
†† Corolla not more than 1.5 cm. long; stems stout, internodes long .... *75. M. Johnstonii*

B. Mature calyx little or not at all inflated, sometimes distended by the mature capsule.
a. Corolla bilabiate, the lobes unequal .... *92. M. Jepsonii*
b. Corolla not bilabiate, the lobes equal or nearly so.
α. Stamens included or upper pair slightly exserted.
I. Capsule ovate-lanceolate, usually well exserted; calyx-teeth acute, about one-fourth as long as the tube.
1. Calyx 4–6 mm. long; leaves mostly short-petioled. . *88. M. mephiticus*
2. Calyx 6–10 mm. long; leaves sessile................ *87. M. densus*
II. Capsule broadly oblong or ovate, scarcely exserted; calyx-teeth lanceolate-subulate, at least one-third as long as the tube.
1. Corolla 8–10 mm. long; anthers glabrous.......... *91. M. leptaleus*
2. Corolla more than 1 cm. long; anthers mostly hispid.
* Corolla less than 1.5 cm. long, usually yellow, often tinged or streaked with red......... .... *93. M. Whitneyi*
** Corolla more than 1.5 cm. long, deep reddish-purple. . *89. M. coccineus*
β. Stamens distinctly exserted........ .... *90. M. stamineus*

70. M. brevipes Benth. Scroph. Ind. 28. 1835; DC. Prodr. **10**:369. 1846; Hook. & Arn. Bot. Beechey's Voyage, 377. 1840; Gray in Proc. Am. Acad. **11**: 97. 1876; Bot. Calif. **1**: 565. 1876; Syn. Fl. N. Am. **2**[1]: 275. 1876, ed. 2, and Suppl. 446. 1886; Bot. Mex. Bound. **2**: 116. 1859; Conzatti & Smith, Fl. Sin. Mex. 118. 1897; Abrams, Fl. Los Angeles, 365. 1904, and ed. 2, 336. 1917.

Eunanus brevipes Greene in Bull. Calif. Acad. Sci. **1**: 105. 1885.

Densely viscid-pubescent annuals; stem 1–7 dm. high, simple or branched; basal leaves broadly oblong or obovate, 5–8 cm. long, 1–4 cm. broad, acute or obtuse, tapering to a slender petiole, irregularly toothed or sometimes entire, cauline leaves few, scattered, usually shorter than the internodes, sessile, narrowly lanceolate or linear, 2–6 cm. long, 2–5 mm. broad, finely toothed; pedicels 2–4 mm. long, occasionally 6–13 mm. long; calyx broadly tubular-campanulate, sometimes slightly narrowed at the oblique

throat, becoming inflated in anthesis and from 8–10 mm. wide, densely glandular-pubescent on the inner and outer surfaces, teeth acute, often acuminate, very unequal, the upper reflexed, at least half as long as the tube and from 2–3 times the length of the others; corolla bilabiate, 2–5 cm. long, yellow, broadly funnelform, the tube short and narrow, expanding abruptly to a long, broad, campanulate throat, ventricose on the lower side, ridges prominent, lobes nearly equal, broad, spreading, the limb 2–4 cm. in diameter; stamens glabrous, included, they and the style and stigma yellow or occasionally green; style slender, included, stigma funnelform, lobes unequal; capsule included, ovate-oblong, acute, 1 cm. long, 4 mm. wide, somewhat coriaceous, opening at the apex and along the upper suture and splitting irregularly down the lower; seeds oblong, apiculate at both ends, papillate.

Distribution: dry sandy or rocky hillsides and mesas from Santa Barbara to northern Lower California.

Specimens examined:

California: Santa Inez Mts., Santa Barbara Co., May, 1902, *Elmer 3933* (Stanford); Sycamore Cañon, Santa Inez Mts., 13 April, 1920, *Jepson 9133* (Calif.); Santa Barbara, May, 1902, *Elmer 3933* (M); Ojai Valley, Ventura Co., 27 June, 1915, *Thacher 55* (Calif.); sandy washes and hillsides, Santa Monica Range, May, 1889, *Hasse* (M); Santa Monica Cañon, 3 July, 1893, *Barber* (R. Mt. and M); Mt. Wilson, 19 July, 1915, *Drushel* (M and Drushel); Santa Monica Mts., 800 ft. alt., 3 April, 1901, *Abrams 1279* (Stanford); open hillsides, Sepulveda Cañon, Santa Monica Mts., 700 ft. alt., 15 May, 1920, *Munz & Harwood 4006* (Pomona); dry shady rocky places, Mt. Lowe, 5000 ft. alt., *G. B. Grant 2423* (Stanford); near creek, Verdugo Cañon, near Los Angeles, 25 June, 1915, *Macbride & Payson 759* (G and R. Mt.); Echo Mt., San Gabriel Mts., 2250 ft. alt., 19 May, 1918, *Pierson 195* (M); Altadena, Los Angeles Co., 1500 ft. alt., 30 June, 1917, *F. Grinnell, Jr.* (Stanford); mountains near Claremont, 15 May, 1909, *C. F. Baker 5322* (Stanford); Coble Canyon, Claremont, 1500 ft. alt., 19 May, 1905, *Cook* (Pomona); wash at Claremont, 15 May, 1918, *I. M. Johnston* (Pomona); Ontario, 30 April, 1893,

Applegate (Stanford); Fish Cañon, San Gabriel Mts., 6 May, 1920, *Ottley 621* (Wellesley and M); Riverside, 17 May–1 June, 1901, *Jepson 1211* (Calif.); Palomar, 17 May–1 June, 1901, *Jepson 1518* (Calif.); Menifee, Riverside Co., April, 1893, *King* (Pomona); dry mesa edge among shrubs, Red Hill, near Upland, San Bernardino Co., 28 April, 1917, *I. M. Johnston 1203* (Stanford and Pomona); dry mesas, San Bernardino Valley, 21 May, 1917, *Parish 11226* (Cornell, M, and Pomona); foothills of the San Bernardino Mts., May, 1885, *Parish & Parish 117* (M); San Bernardino Valley, 1200 ft. alt., 8 May, 1906, *Parish 5620* (R. Mt.); mouth of Icehouse Cañon, San Antonio Mts., 5000 ft. alt., 16 June, 1918, *Parish 11958* (Cornell); San Bernardino, 1100 ft. alt., 15–23 May, 1913, *Jepson 5552* (Calif.); San Bernardino Co., 1876, *Parry & Lemmon 310* (M); vicinity of San Bernardino, 1000–2500 ft. alt., 4 May, 1901, *Parish 4755* (Stanford); Santa Ysabel, 25 April, 1893, *Henshaw* (M); in Cajon Hills, 10 April, 1891, *Dunn* (Stanford); Cajon Pass, 28 May, 1914, *Jepson 6106* (Calif.); Viegas Valley, San Diego Co., June, 1877, *Cleveland* (M); on dry hills near Campo, San Diego Co., 21 May, 1903, *Abrams 3597* (Phil., M, and Stanford); slopes and benches of the south side, San Jacinto Mts., 5000 ft. alt., June, 1901, *H. M. Hall 2058* (M, Stanford, and Calif.); Arrowhead Hot Springs, San Diego Co., 23 May, 1906, *G. B. Grant 6636* (Stanford); San Luis Rey River Valley, 15 May, 1917, *Street* (Pomona); common in open fields around Hemet and San Jacinto, 30 May, 1919, *Jenkins & Street 1938* (Pomona); between the Tia Juana River and Laguna, San Diego Co., 9 June, 1894, *Mearns 3507* (Stanford); Jacumba Hot Springs, San Diego Co., 31 May, 1894, *Schoenfeldt 3347* (Stanford); Del Mar, San Diego Co., May, 1894, *Angier 33* (M); San Diego, June, 1895, *Stokes* (Stanford); Coronado Beach, San Diego, 21 April, 1895, *Fritchey* (M); among bushes, Golf Links, La Jolla, 25 April, 1914, *Clements & Clements 125* (M and Calif.); Harvey's Ranch near El Nido, San Diego Co., 20 May, 1903, *Abrams 3531* (Stanford); wayside, Palomar Mt., San Diego Co., 12 Aug., 1919, *Spencer 103* (Pomona); hills, San Diego, 4 May, 1882, *Pringle* (M); southern part of San Diego Co., 1875, *Edw. Palmer 278*

(M); Live Oak Springs, Laguna Mts., Imperial Co., 3000 ft. alt., 6 Aug., 1916, *McGregor 105* (Stanford).

Mexico:

Lower California: dry hills, northern Lower California, 22 May, 1886, *Orcutt 133* (M); Nachoguero Valley, 4 June, 1894, *Schoenfeldt 3480* (U. S.); San Telmo, northern Lower California, 17 April, 1886, *Orcutt* (Calif.).

71. **M. Bolanderi** Gray in Proc. Am. Acad. **7**: 380. 1867; Bot. Calif. **1**: 565. 1876; Syn. Fl. N. Am. **2**^{1}: 275. 1878, and ed. 2, 1886; Jepson, Fl. W. Mid. Calif. 404. 1902, and ed. 2, 377. 1911; Eastwood, Fl. South Fork King's River, Sierra Club Publ. 27: 66. 1902; Hall, Yosemite Fl. 224. 1912.

M. brevipes Gray in Pac. Rail. Rept. **4**: 120. 1856, not Benth.

Eunanus Bolanderi Greene in Bull. Calif. Acad. Sci. **1**: 105. 1885.

Densely glandular-pubescent annuals; stem erect, simple or branched, often more or less nigrescent, very viscid; leaves obovate or oblong, 2–7 cm. long, 1–2.5 cm. broad, acute, entire or sometimes denticulate along the upper part, yellow-green to dark green above, often reddish-purple below, sessile, 3–5-nerved from the base; pedicels 3–4 mm. long; calyx campanulate, 1.5–2.5 cm. long, sharply angled, glandular-pubescent on the inner surface as well as the outer, more or less constricted at the very oblique throat, 5–8 mm. wide, teeth lanceolate, unequal, the upper acuminate, recurved, at least twice the length of the others and often half as long as the tube; corolla bilabiate, 2.5–4 cm. long, pale pink to deep reddish-purple, tube pubescent externally, slender, slightly exserted beyond the calyx-throat, abruptly expanding to a deep broad open throat, usually 1.3–1.5 cm. wide, lobes relatively short, unequal, the lower lip with two white lines running down the densely hairy ridges, these often dotted with darker red; stamens glabrous, included; style included, lobes of the stigma very unequal, the longer one lanceolate, acuminate; capsule slender, acuminate, shorter than the calyx; seeds oval, apiculate at both ends, tuberculate.

Distribution: dry open places, in the foothills of the Sierra Nevada Mts. from Calaveras Co. to Tehachapi, and in the Coast

Ranges from Mendocino Co. to Monterey Co., California. Often appearing in burned-over areas.

Specimens examined:

California: Ukiah, June, 1882, *Rattan* (G and M); Ukiah, June, 1884, *Rattan* (Stanford); near Purdy's Garden, east of Ukiah, 2500 ft. alt., 3 June–5 July, 1903, *Jepson 2247* (Calif.); in hills about Scott's Valley, northwest of Lakeport, Lake Co., 28 May–2 June, 1902, *Tracy 1747* (Calif.); West Point Bridge, Calaveras Co., 2300 ft. alt., 7 July, 1896, *Hansen 1809* (M and Stanford); Knight's Ferry on the Stanislaus River, *Bigelow* (N. Y.); burned areas in *Adenostoma* thickets, Rawhide Hill, Tuolumne Co., 1400 ft. alt., 17 May, 1919, *Williamson* (Stanford); Punch Bowl Road, near Rawhide, 13 Aug., 1915, *Stinchfield 138* (Stanford); Columbia, Tuolumne Co., 2 June, 1915, *Jepson 6352* (Cornell, M, and Calif.); Confidence, Tuolumne Co., 4000 ft. alt., 19 July, 1911, *Abrams 4726* (Stanford); beyond South Fork Bridge on road to Hetch-Hetchy Valley, 4000 ft. alt., 10 June, 1916, *A. L. Grant 809* (M and Stanford); Mariposa, 17 June, 1892, *Congdon* (Stanford); dry hillsides, Clark's Ranch, Mariposa Co., 1866, *Bolander 6314* (G, TYPE, and U. S.); roadside east of Dry Creek, Kaweah River Valley, 23 July, 1896, *Dudley 1369* (Stanford); Hites Cove, 30 May, 1883, *Congdon* (G); Tehachapi, June, 1884, *Curran* (Stanford); by Soda Springs stage road, Santa Clara Co., 3 June, 1895, *Dudley 3997* (Stanford); Tassajara Hot Springs, Monterey Co., June, 1901, *Elmer 3356* (M and Stanford); hills, upper San Antonio Creek, Santa Lucia Mts., 14–20 June, 1901, *Jepson 1656* (Calif.).

This is an interesting species related to *M. Rattani* in its northern limit and to *M. subsecundus* in its southernmost stations. It grows in dry open places in the Sierra Nevada Mts., where it frequently appears in great abundance following chaparral fires. It is extremely viscid, so much so that according to Rattan "house flies are captured when they alight on its stem." It has a strong odor of *Nicotiana* and is often called "Wild Tobacco."

71a. Var. brachydontus Grant[1]

Leaves smaller, oblong to oblanceolate, 1.5–3.5 cm. long; calyx 1–1.5 cm. long, 4–6 mm. wide, throat very oblique, teeth broadly triangular-acute, about equal in length or more often with the upper tooth somewhat longer and straight or slightly curved; corolla 1.7–2 cm. long, the lips shorter and more nearly equal than in the species.

Distribution: dry open places from the Coast Ranges in northern California, south to Lake Co., Sierra Nevada Mts., from Colusa Co. to Fresno Co., California.

Specimens examined:

California: west of Bennett Spring on the Newville-Covelo Road, Glenn Co., 3000 ft. alt., 16 June, 1915, *Heller 11992* (M and Stanford); open gravelly places, between Mud Flat and Bennett Spring, 2500 ft. alt., 3 June, 1915, *Heller 11927* (M and Stanford); Bruno Valley, Lake Co., May, 1902, *Bowman 219* (Stanford); Hough's Springs, north Lake Co., 24 May, 1920, *Jepson 9054* (Calif.); Uncle Sam Mt., Lake Co., July–Aug., 1892, *Jepson 22m* (Calif.); Colusa Co., June, 1884, *Rattan* (Stanford); Hetch-Hetchy Valley, 3660 ft. alt., 15 June, 1918, *A. L. Grant 1264* (G, Phil., U. S., Cornell, M, TYPE, Calif., and Stanford); Mariposa, 14 May, 1882, *Congdon* (G); Aqua Fria, Mariposa Co., 19 May, 1895, *Congdon* (Stanford); Alder Creek Trail, Yosemite Park, 4500 ft. alt., 1 July, 1911, *Jepson 4314* (Calif.); Grant's Springs, Mariposa Co., 30 June, 1896, *Congdon* (Calif.); Raymond, 9 June, 1894, *Burnham* (Cornell); road from Raymond to Yosemite, 11 June, 1891, *Fritchey 1* (M); Mariposa Big Tree Grove, July, 1878, *Lemmon* (M); dry, open hillsides between Cascada and Huntington Lake, Fresno Co., 6500 ft. alt., 25 June, 1917, *A. L. Grant 1005* (Cornell and M); above Cascada, Fresno Co., 5500 ft. alt., 6 July, 1917, *A. L. Grant 1065* (M); Squaw Valley to

[1] **Mimulus Bolanderi** Gray var. **brachydontus** Grant, var. nov., folii parviores, oblongi oblanceolative, 1.5–3.5 cm. longi; calyce 1–1.5 cm. longo, 4–6 mm. lato, fauce obliquo, dentibus late triangulari-acutis, superiore dente valde longiore; corolla 1.7–2 cm. longa, laciniis brevioribus, fere aequalibus.—Collected in Hetch-Hetchy Valley, Tuolumne Co., California, 3660 ft. alt., 15 June, 1918, *Adele Lewis Grant 1264* (Gray Herb., Phil. Acad. Nat. Sci. Herb., Cornell Univ. Herb., Mo. Bot. Gard. Herb., no. 893308, TYPE, Univ. Calif. Herb., and Stanford Univ. Herb.).

Dunlap, Fresno Co., 17 May, 1907, *Jepson 2751* (Calif.); Sierra Nevada, without date, *Anderson* (G).

The variety seems, at first, to be distinct, based on differences in size, width of throat, length of calyx-teeth in relation to each other, and the amount of curvature of the longer calyx-tooth. A careful examination of a number of specimens, however, shows that these differences are not constant. In some, the teeth are of nearly the same length and straight, while in others the upper tooth is distinctly longer, though not always recurved. The specimens of T. S. Brandegee from Snow Mt. have yellow corollas, according to a note on the label.

72. **M. Parryi** Gray in Proc. Am. Acad. **11**: 97. 1876; Bot. Calif. **1**: 565. 1876; Syn. Fl. N. Am. **2**[1]: 275. 1878, and ed. 2, 1886.

Eunanus Parryi Greene in Bull. Calif. Acad. Sci. **1**: 104. 1885; Rydb. Fl. Rocky Mountains, 781. 1917.

Small glandular-puberulent annuals; stem simple or with a few short branches, flowering freely from near the base; leaves oblong to lanceolate, 1–2 cm. long, 2–4 mm. wide, entire, nearly glabrous, tapering to a slender base; pedicels 2–3 mm. long; calyx campanulate, 8–10 mm. long, 3–4 mm. wide when mature, glandular-puberulent, scarious below the sinuses, throat very oblique, not constricted, teeth broadly triangular, acute, the upper tooth twice as long as the lateral ones, the latter tending to become subulate; corolla bilabiate, funnelform, 1.5–2 cm. long, yellow, sometimes tinged with reddish-purple, tube short, included, throat glabrous or puberulent externally, less than twice as long as the calyx, lobes broad, rounded, widely spreading; stamens glabrous, unequally inserted, longer pair with broad filaments, the shorter with slender filaments, anthers small; style sparsely puberulent, stigma-lobes nearly equal, bilamellate; capsule slightly longer than the calyx-tube, lanceolate, obtuse; seeds apiculate at each end, tuberculate.

Distribution: southern Utah.

Specimens examined:

Utah: abundant on gravelly hills near St. George, April, 1874, *Parry 147* (G, TYPE, and M); St. George, Mokiah Pass, southern

Utah, 1877, *Edw. Palmer 383* (G and M); St. George, 13 April, 1880, *Jones 1655* (Pomona); Diamond Valley, 4500 ft. alt., 28 April, 1894, *Jones* (Pomona).

73. **M. spissus** Grant[1] Pl. 7.

A stout, much branched, glandular-villous annual; stem 15 cm. high; flowers and leaves densely crowded toward the ends of the branches; leaves broadly obovate, 1–1.5 cm. long, 4–6 mm. broad, acute or cuspidate, entire, 3–5-nerved from the base, villous, tapering to a short slender petiole; pedicels 1–2 mm. long; mature calyx broadly campanulate, much inflated, 8–9 mm. long, scarious between the green ribs, teeth unequal, lanceolate-subulate, the three upper longer and broader than the others, nearly half as long as the calyx; corolla funnelform, 1.5–1.8 cm. long, pink, more or less tinged and streaked with red, tube much exserted, throat broad, with two densely yellowish hairy patches below the lower lip, lobes nearly equal; stamens glabrous, included in the tube; style included; stigma-lips unequal, broadly rounded, ciliate; capsule lanceolate, arcuate; seeds smooth, at least twice as long as broad.

Distribution: known only from the type locality.

Specimens examined:

Nevada: Silver Peak Mts., 5000 ft. alt., 29 Sept., 1915, *Goldman 2548* (U. S., TYPE).

74. **M. Bigelovii** Gray in Proc. Am. Acad. **11**: 96. 1876; Bot. Calif. **1**: 564. 1876; Syn. Fl. N. Am. **2**[1]: 274. 1878, ed. 2, and Suppl. 444. 1886; Abrams, Fl. Los Angeles, 365. 1904, and ed. 2, 335. 1917.

Eunanus Bigelovii Gray in Pac. Rail. Rept. **4**: 121. 1856; Watson, Bot. King's Exp. 226. 1871; Greene in Bull. Calif. Acad. Sci. **1**: 102. 1885; Howell, Fl. Northwest Am. 518. 1903; Rydb. Fl. Rocky Mountains, 780. 1917.

[1] **Mimulus spissus** Grant, sp. nov., annuus, crassus, multo ramosus glanduloso-villosus; caule 15 cm. alto; foliis floribusque dense spissis ad terminos ramorum; foliis late obovatis, acutis cuspidatisve, villosis; fructifero calyce multo inflato, 8–9 mm. longo, dentibus inaequalibus, lanceolatis, subulatis, tribus proximis alteris longioribus latioribusque et fere calycis dimidiis; corolla 1.5–1.8 cm. longa, pallida rosea plus minusve rubro-colorata.—Collected on Silver Peak Mts., 5000 ft. alt., 29 Sept., 1915, *E. A. Goldman 2548* (U. S. Nat. Herb. no. 767707, TYPE).

Stem simple or more often branched, 5–25 cm. high, glandular-pubescent, frequently tawny viscid-villous on the calyx and lower surface of the leaves; leaves thin, scattered, broadly obovate or elliptical, 1.5–3.5 cm. long, 5–12 mm. broad, acute, entire or occasionally minutely toothed toward the apex, mostly 1-nerved, tapering to a slender petiole or the upper leaves often subsessile; flowers usually clustered at the tips of the stem and branches, pedicels 1.5–3 mm. long; calyx broadly oblong, 8–12 mm. long, throat more or less oblique, teeth sharply subulate from a broad base, unequal, the lower teeth smaller, about one-third as long as the tube; corolla reddish-purple, 1.5–3 cm. long, tube mostly included, throat narrowly funnelform, often with a large yellow patch extending down the yellow tube, and expanding abruptly to a broad spreading almost rotate limb, 1.5–2 cm. wide, the lobes subequal with rounded sinuses; stamens included in the lower part of the throat, anthers usually somewhat hispid; style included, stigma-lobes broadly peltate-funnelform, equal, capsule slender, lanceolate, tapering to a narrow blunt apex, often incurved, rarely longer than the uppermost calyx-tooth; seeds oblong, rounded at both ends, papillate.

Distribution: western Nevada, Arizona, and throughout the arid regions of California from Tulare Co. to Imperial Co.

Specimens examined:

Arizona: Zucca, 21 May, 1884, *Jones* (Pomona).

Nevada: log railroad north of Verdi, Washoe Co., 5300 ft. alt., 30 June, 1913, *Heller 10890* (Stanford); Eldorado Cañon at Nelson, 3000 ft. alt., 30 April, 1907, *Jones* (Pomona).

California: Water Canyon, Tehachapi Mts., Kern Co., 6500 ft. alt., 26 June, 1908, *Abrams & McGregor 464* (Stanford); summit, Mt. Wilson, 15 June, 1906, *G. B. Grant 6688* (Cornell, M, and Stanford); Wilson's Peak, Los Angeles Co., 10 July, 1901, *Abrams 1892* (Stanford); summit of Mt. Wilson, Los Angeles Co., 30 June, 1902, *Abrams 2588* (G and M); King's Cañon, Liebre Mts., Los Angeles Co., 7 June, 1896, *Dudley & Lamb 4359* (Stanford); hill above Cuddy's, Cuddy Canyon, Mt. Pinos region, 15 June, 1896, *Dudley & Lamb 4504* (Stanford and Pomona); Swarthout Cañon, San Antonio Mts., June, 1887, *Parish 1982* (Calif.); sandy wash, 11 miles west of

Needles, 31 March, 1920, *Munz 3613* (M and Pomona); The Needles, 8 May, 1884, *Jones 3860* (R. Mt. and Pomona); Thermal, 3 May, 1903, *Davidson 1108* (Davidson); foothills west of Bishop, Inyo Co., 18 May, 1906, *Heller 8279* (M and Stanford); Andrews' Camp, Bishop Creek, Inyo Co., July, 1911, *Davidson 2697* (Davidson); Cushenberry Cañon, San Bernardino Co., 15 June, 1895, *Parish* (Stanford); Lone Willow Spring, Mohave Desert, San Bernardino Co., 8 May, 1915, *Parish 10119* (Stanford); hillside, Copper City, Mohave Desert, 13 May, 1922, *I. M. Johnston 5590* (Pomona); Fort Mojave, ravines in gravel, 6 Feb., 1860–61, *Cooper* (G); Ord Mts., near Kane Spring, Mohave Desert, 4200 ft. alt., 1 May, 1906, *Hall & Chandler 6790* (R. Mt. and Pomona); Ord Mts., Mohave Desert, 2 May, 1914, *Jepson 5862* (Calif.); Stoddard's Well, Mohave Desert, 9 May, 1914, *Jepson 5911* (Calif.); Mohave Creek near the Colorado, 2 Mar., 1854, *Bigelow*, in Whipple's Exp. (G, TYPE, and N. Y.); gravelly hills near the Colorado of California, 17 Feb., 1854, *Bigelow* (G); Cottonwood Springs, Colorado Desert, Riverside Co., 2200 ft. alt., May, 1905, *H. M. Hall 6011* (Stanford); Borrego Valley, western Colorado Desert, San Diego Co., 26 April, 1920, *Jepson 8797* (Cornell and Calif.); Vallecito, western Colorado Desert, 15 April, 1920, *Jepson 8580* (Cornell, M, and Calif.); southwestern part, Colorado Desert, April, 1889, *C. R. Orcutt* (M and Stanford); San Felipe Canyon, Colorado Desert, 13 April, 1913, *Eastwood 1738a* (G); Morongo, borders of the Colorado Desert, April, 1882, *Parish 1217* (M); Hananpah Cañon, Panamint Mt., 4000 ft. alt., 7 May, 1917, *Jepson 6956* (Calif.); between Coyote Wells and Cement Bridge, Imperial Co., 1 April, 1917, *McGregor 837* (Stanford); Aqua Caliente, April, 1884, *Parish & Parish* (G and Stanford); Vallecito, San Diego Co., 17 April, 1920, *Jepson 8945* (Calif.).

74a. Var. **cuspidatus** Grant[1]

Plants stouter, branching more freely and regularly, densely viscid-villous; leaves thick, broadly obovate or rhomboid, mostly

[1] **Mimulus Bigelovii** Gray var. **cuspidatus** Grant, var. nov., herba crassior, libere ramosa, dense viscido-villosa; foliis spissis, late obovatis rhomboidibusve, fere cuspidatis, 3–5-nervatis; corolla parviore, 1–2 cm. longa; staminibus glabris.—

abruptly cuspidate, 3–5-nerved, tapering to a slender short-petioled base; pedicels 3–8 mm. long, usually longer than in the species; corolla smaller, 1–2 cm. long; stamens glabrous; stigma-lobes unequal; capsule arcuate, often exceeding the calyx.

Distribution: arid region of western Nevada and central California.

Specimens examined:

Nevada: Steamboat Springs, Washoe Co., 9 Aug., 1906, *Kennedy 1487* (Stanford); 10 miles below Mica Springs, 2000 ft. alt., 13 April, 1894, *Jones 5054* (M, TYPE, U. S., R. Mt., and Pomona); Rhyolite, Tonopah, 3600 ft. alt., 1 June, 1907, *Shockley 50* (Stanford); Panaca, 6 Sept., 1912, *Jones* (Calif., Stanford, and Pomona); Bennett Spring, Highland Range, May–Oct., 1898, *Purpus 6304a* (Calif.); Pahroc Spring, 3000–4000 ft. alt., Aug., 1898, *Purpus 6304* (Calif.).

California: Furnace Creek, Death Valley, 2300 ft. alt., *Jepson 6888* (Calif.); rocky slopes of Argus Mts., 3000–4000 ft. alt., Apr.–Sept., 1897, *Purpus 5348a* (M); Ibex Spring, Inyo Co., 22 May, 1915, *Parish 10039* (Calif. and Stanford); Toll House near Big Pine, Inyo Co., 1898, *Purpus 5786* (Calif.); Silver Canyon in the White Mts., east of Laws, Inyo Co., 7 May, 1906, *Heller 8194* (M and Stanford); dry hills, Barstow, Mohave Desert, 29 May, 1914, *Parish 9242* (Cornell and M); Morongo, April, 1882, *Parish & Parish* (M).

75. **M. Johnstonii** Grant[1]

Stem stout, erect, branches few, irregular, appearing from the base to half way up the stem, glandular-pubescent; leaves broadly obovate to rhomboid, 1.5–2 cm. long, 4–10 mm. broad, acute,

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Collected 10 miles below Mica Springs, 2000 ft. alt., 13 April, 1894, *Marcus E. Jones 5054* (U. S. Nat. Herb., Mo. Bot. Gard. Herb., no. 106688, TYPE, and Rocky Mt. Herb.).

[1] **Mimulus Johnstonii** Grant, sp. nov., caulis crassus, rami pauci, glanduloso-pubescentes; foliis late obovatis rhomboidibusve, 1.5–2 cm. longis, 4–10 mm. latis; calyce late campanulato, 8–10 mm. longo, inflato et infirme angulato, dentibus deltoidibus, acuminatis, inaequalibus; corolla rosea, laciniis brevibus, limbo 1–2 cm. lato; capsula lanceolata, obtusa.—Collected under pines, San Antonio Cañon, San Antonio Mts., Los Angeles Co., 6000 ft. alt., 28 July, 1917, *Ivan M. Johnston 1562* (Gray Herb., Mo. Bot. Gard. Herb. no. 893569, TYPE, Stanford Univ. Herb., and Pomona Coll. Herb.).

tapering to a short broad petiole, thick, 1–3-nerved from the base; flowers axillary, flowering from near the base and usually closely clustered at the tips of the branches, pedicels slender, 3–6 mm. long; calyx broadly campanulate, 8–10 mm. long, inflated and weakly angled when mature, membranous, the teeth herbaceous, broadly deltoid, sharply acuminate, unequal, the upper tooth longer and recurved, throat expanded, oblique; corolla funnelform, 1.3–1.5 cm. long, rose-red, more or less shaded and streaked with darker red, tube included, throat short with a large hairy yellow patch on the lower side, lobes short, rounded, subequal, the limb 1–2 cm. in diameter; stamens glabrous, the upper pair and the style usually exserted; stigma-lips equal, ciliate; capsule lanceolate, obtuse, slightly incurved at the apex, about as long as the uppermost calyx-tooth; seeds oval, smooth, apiculate at each end, about 1 mm. long.

Distribution: known only from the San Antonio Mts. in southern California. Common on dry ground under the pines in the Canadian Zone.

Specimens examined:

California: under pines, San Antonio Cañon, San Antonio Mts., Los Angeles Co., 6000 ft. alt., 28 July, 1917, *I. M. Johnston 1562* (G, M, TYPE, Stanford, and Pomona); common under pines, Baldy Lookout of U. S. Forest Service, San Antonio Mts., 7000 ft. alt., 20 June, 1917, *I. M. Johnston 1486* (Stanford and Pomona); Cucamonga Mts., San Bernardino Co., 5000 ft. alt., July, 1920, *Childs* (M).

Its stout stems, long internodes, small flowers, and usually slightly exserted style and stamens will serve to separate this species from *M. Bigelovii*, with which it has been confused. The seeds are interesting in that they are fully twice as large as those of any of the other species in this section except *M. Cusickii*. The specific identity of these plants was first questioned by I. M. Johnston in his paper "The Flora of the Pine Belt of the San Antonio Mountains of Southern California" (Plant World **22**: 116. 1919).

76. M. Cusickii (Greene) Piper, Contr. U. S. Nat. Herb. **11**: 508. 1906.

M. Bigelovii var. *ovatus* Gray, Syn. Fl. N. Am. ed. 2, 2[1]: Suppl. 445. 1886.

Eunanus Cusickii Greene, Pittonia 1: 36. 1887; Howell, Fl. Northwest Am. 518. 1903.

More or less glandular-pubescent plants; stem stout, erect, simple or branched, 1–4 dm. high; leaves ovate, 1–3.5 cm. long, 1.8–2 cm. wide, acute or cuspidate, mostly distinctly 3-nerved at the broad base, upper leaves closely sessile, lower sometimes tapering to a short broad petiole; flowers scattered along the axis and in more or less close clusters at the tips of the stems, pedicels 1–2 mm. long; calyx ovate-campanulate, 1.2–1.5 cm. long, usually somewhat constricted at the oblique throat, teeth broad at the base, becoming abruptly subulate, unequal; corolla funnelform, 2–3 cm. long, reddish-purple, tube yellowish, exserted, expanding gradually to a wide open throat, densely bearded and with one or two large yellow patches or streaks spotted with red below the lower lip, lobes nearly equal, rotately spreading, broad with rounded sinuses, 1.5–2.5 cm. wide; stamens included, filaments of the longer pair glandular-pubescent, anthers hispid; style slightly exserted, densely pubescent, stigma-lips rounded, subequal, ciliate; capsule lanceolate, obtuse, more or less incurved, exserted; seeds oval, apiculate at each end, smooth.

Distribution: sandy or rocky places in western Idaho, Nevada, and Oregon.

Specimens examined:

Idaho: in the lava, Murphy, Owyhee Co., 4 July, 1911, *Nelson & Macbride 1032* (R. Mt.).

Nevada: Lake Washoe, 1865, *Torrey 372* (G, type of *M. Bigelovii* var. *ovatus* Gray).

Oregon: steep sandy hillsides of Crook Co., 2 July, 1901, *Cusick 2630* (Cornell, M, and R. Mt.); sands of the Walker Basin, Crook Co., 1 Sept., 1902, *Cusick 3009* (Cornell, M, and Stanford); stony hillsides of Ochoco, in great abundance, 3 Sept., 1902, *Cusick 2997* (Cornell, M, and Stanford); hillsides of Cottonwood Creek, near the Malheur, 20 June, 1898, *Cusick 1951* (G, Cornell, and M); Malheur River, eastern Oregon, 1885, *Cusick 1262* (G); Mitchell, Aug., 1893, *Wilson* (Stanford); Muddy Station, John Day Valley, 12 May, 1885, *Howell* (G,

Phil., and Ore.); sands of the desert near Squaw Creek, Crook Co., 13 June, 1902, *Cusick 2810* (G, Cornell, and M); yellow pine forest, 1 mile west of Sister's, Crook Co., 27 June, 1919, *Ferris & Duthie 560* (Stanford); mts. of Oregon, 1875, *Nevins* (G); John Day River, 22 Sept., 1896, *Cole* (Ore.).

This species can be separated from *M. Bigelovii*, with which Dr. Gray originally confused it, by its stouter, longer and more erect stems, and by its larger leaves which usually are broadly ovate, subulate, 3-nerved at the base and closely sessile. The strongly oblique calyx-throat and the densely glandular-pubescent exserted style further help to distinguish it.

77. **M. Fremontii** (Benth.) Gray in Proc. Am. Acad. **11**: 96. 1876; Bot. Calif. **1**: 565. 1876; Syn. Fl. N. Am. 2^1: 275. 1878, ed. 2, and Suppl. 445. 1886; Conzatti & Smith, Fl. Sin. Mex. 118. 1897; Abrams, Fl. Los Angeles, 365, 1904, and ed. 2, 335. 1917.

Eunanus Fremontii Benth. DC. Prodr. **10**: 374. 1846; Greene in Bull. Calif. Acad. Sci. **1**: 103. 1885; Wats. Bot. King's Exp. 226. 1871.

Stem red, 4–20 cm. high, usually freely branched from near the base, more or less villous with white shaggy hairs, viscid or glandular-pubescent, or occasionally nearly glabrous; leaves oblong, oblanceolate, or spatulate, 1–3 cm. long, 2–8 mm. wide, tapering to a slender sessile base, often irregularly toothed along the upper part, lower leaves commonly broadly obovate, petioled and more or less tinged with red; flowers numerous on short pedicels, 1–2 mm. long and often crowded toward the tips of the stems; calyx broadly campanulate, 8–10 mm. long, somewhat enlarged when mature, constricted slightly at the oblique throat, teeth broadly triangular, acute or obtuse, 2 mm. long, nearly equal; corolla broadly funnelform, 2–2.5 cm. long, rose-red with darker markings down the throat, the proper tube mostly included, throat with two yellow ridges more or less spotted with red down the lower side, fully as long as the calyx, expanding to a broad, spreading limb, 1.3–1.8 cm. in diameter, lobes rounded, somewhat unequal; stamens short, included in the lower half of the throat, glabrous, or the filaments of the longer pair short, glandular-pubescent; style sparsely glandular-pubescent, the

stigma-lobes nearly equal, peltate-funnelform; capsule lanceolate, attenuate, often arcuate, about as long as the calyx; seeds oblong, reticulate, apiculate at both ends.

Distribution: dry sandy open places in the interior of California, southward into Lower California; especially common in the desert regions. Possesses a strong mephitic odor.

Specimens examined:

California: grassy western slopes of Big Pinnacles, Monterey Co., 27 April, 1919, *Ferris 1729* (Stanford); mountain sides near falls above New Idria, Monterey Co., 31 May, 1899, *Dudley* (Stanford); Priest Valley to New Idria, San Carlos Range, 12 May, 1907, *Jepson 2680* (Calif.); Mt. Diablo, April, 1878, *Lemmon* (M); Paso Robles, San Luis Obispo Co., 23 April, 1899, *Barber* (Calif.); Tehachapi, Kern Co., 5 May, 1905, *Heller* (Calif.); Mono Flat, Santa Barbara Co., 18 May, 1907, *H. M. Hall 7791* (R. Mt., Calif., and Pomona); Topatopa Mts., Ventura Co., 6000 ft. alt., 4–6 June, 1908, *Abrams & McGregor 99* (U. S., Stanford, and Pomona); Seymour Creek, Mt. Pinos, Ventura Co., 10 June, 1923, *Munz 7005* (Pomona); San Dimas Wash near Claremont, 27 April, 1902, *Bixby* (Pomona); Big Tunga Wash, Los Angeles Co., 6 April, 1901, *Abrams 1379* (Stanford and Pomona); Glendora, Los Angeles Co., 7 May, 1904, *G. B. Grant 6203* (Phil., M, Calif., Stanford, and Pomona); Colton, 27 April, 1882, *Jones 3188* (M); exposed south slopes in the vicinity of Chalk Hill, San Jacinto Mts., 5000 ft. alt., June, 1901, *H. M. Hall 2049* (Stanford and Pomona); Oro Grande Wash, west of Hesperia, 17 May, 1920, *I. M. Johnston 2312* (Pomona); dry mesas, San Bernardino Valley, 21 May, 1917, *Parish 11225* (Cornell and Pomona); sandy banks of the Mohave River, San Bernardino Co., 3500 ft. alt., 29 May, 1901, *Parish 4904* (U. S. and Stanford); hillsides, San Jacinto Cañon, 17 May–1 June, 1901, *Jepson & Hall 1293* (Calif.); Idyllwild, San Jacinto Mts., 5300 ft. alt., 16 June, 1921, *Spencer* (Pomona); sandy plains, Highlands, San Bernardino Co., May, 1888, *Parish* (Calif.); dry mesas, San Bernardino Valley, 12 June, 1918, *Parish 11912* (M); Swarthout Canyon, San Antonio Mts., 6000 ft. alt., 3–6 June, 1900, *H. M. Hall 1543* (M); San Bernardino Valley, 1000 ft. alt., 8 May, 1906,

Parish 5619 (R. Mt.); vicinity of San Bernardino, 1000–2500 ft. alt., 18 May, 1901, *Parish 4791* (Stanford); Edgar Cañon, San Bernardino Mts., 2500 ft. alt., 13 June, 1894, *Parish 3016* (M and Stanford); Mentone, San Bernardino Co., May, 1903, *R. J. Smith* (Phil., M, and R. Mt.); San Bernardino Co., 1876, *Parry & Lemmon 309* (M); Mill Creek Cañon, San Bernardino Co., 4000 ft. alt., 20 June, 1901, *Parish 5094* (Stanford); San Bernardino Valley, May, 1913, *Jepson 5581* (Calif.); Temescal Wash, southern California, 17 May–1 June, 1901, *Jepson 1573* (Calif.); Cuyamaca Mt., June, 1880, *Parish 465* (Stanford); Buckman Springs, 3000 ft. alt., May, 1893, *Stokes* (Stanford); in dry washes, Campo, San Diego Co., 25 May, 1903, *Abrams 3596* (Stanford); San Felipe, San Diego Co., 16 April, 1895, *T. S. Brandegee* (Calif.); San Ysabel, San Diego Co., 4 May, 1893, *Henshaw* (M); San Diego, April, 1882, *Jones* (R. Mt.); Hesperia, April, 1892, *Trelease* (M); Summit, Imperial Co., 4035 ft. alt., 10 June, 1917, *McGregor 954* (Stanford); southern part of California, *Fremont* (N. Y., part of *type collection*); Blair Valley, San Diego Co., 19 April, 1920, *Jepson 8681* (M, Cornell, and Calif.).

Mexico:

Lower California: mts. of Lower California, 3 July, 1884, *Orcutt 1094* (M and Calif.); Nachoguero Valley, Lower California, 4 June, 1894, *Schoenfeldt 3416* (Stanford).

The specimens of *Abrams 3596* from Campo, San Diego Co., have nearly obsolete calyx-teeth on some of the plants.

78. **M. subsecundus** Gray, Syn. Fl. N. Am. ed. 2, **2**[1]: Suppl. 445. 1886. Pl. 10, fig. 17.

Eunanus subsecundus Greene, Pittonia **1**: 37. 1887.

Stem freely and diffusely branched from the base, 8–21 cm. long, densely viscid-pubescent with scattered white hairs; leaves sessile, oblong or oblanceolate, .8–2.5 cm. long, .3–1.5 cm. wide, obtuse, entire or occasionally denticulate; flowers numerous, sometimes mostly on one side of the stem, frequently in spike-like terminal clusters, subsessile, the pedicels 1–2 mm. long; mature calyx broadly ovate, 7–12 mm. long, 4–5 mm. wide, more or less constricted at the oblique throat, scarious below the sinuses,

angles deeply plicate, teeth short, deltoid, acute; corolla 1.7–2 cm. long, deep reddish-purple, pubescent externally, tube slender, mostly included, throat ventricose, abruptly enlarged to the somewhat spreading pinkish limb, lobes quadratish, short, subequal; stamens and style included, anthers glabrous; stigma peltate-funnelform, the lobes unequal; capsule slender, lanceolate, cylindrical, obtuse, about as long as the calyx or sometimes slightly exserted; seeds oblong, apiculate at one end, tuberculate.

Distribution: foothills of the Coast Ranges from Monterey Co. to San Luis Obispo Co., California. Not often collected.

Specimens examined:

California: dry soil near Mt. San Carlos, 3000 ft. alt., 23 July, 1861, *Brewer 780* (G, TYPE, and Calif.); Valley of the San Joaquin, 1 Aug., 1883, *Meehan* (G, Phil., and M); Tassajara Hot Springs, Monterey Co., June, 1901, *Elmer 3371* (M and Stanford); Santa Lucia Mts., May–July, 1892, *Vortriede* (Calif.); by road near creek, above San Antonio Mission, Monterey Co., 13 May, 1895, *Dudley* (Stanford); Upper San Antonio River, Santa Lucia Mts., 14–20 June, 1901, *Jepson 1651* (Calif.); Pine Mt., San Simeon Bay, San Luis Obispo Co., 22 July, 1876, *Edw. Palmer 322* (G and Calif.).

78a. Var. viscidus (Congdon) Grant, comb. nov.

M. viscidus Congdon in Erythea 7: 187. 1899.

Plant more nearly erect; corolla-lobes mostly pink, more or less lined with red down the throat, sometimes with two white patches below the lower lip; anthers hairy along the back; stigma-lips equal.

Distribution: hot dry hillsides from Tuolumne Co. to Fresno Co. Commonly found on burned-over areas, often covering the ground.

Specimens examined:

California: Mokelumne Hill, Calaveras Co., 5 June, 1885, *Rattan* (Stanford); Gwin Mine, Calaveras Co., 17 May, 1902, *Jepson 1797* (Calif.); abundant in burned-over areas, Vallecito, Calaveras Co., 1748 ft. alt., 12 June, 1915, *A. L. Grant 6m* (M and Calif.); Rose Creek above Columbia, Tuolumne Co., 16 May, 1916, *A. L. Grant 781* (G, Cornell, U. S., M,

Calif., and Stanford); common on burned-over area, Priest's Grade Hill below Groveland, Tuolumne Co., 3 June, 1916, *A. L. Grant 793* (M, Calif., and Stanford); Coulterville, 3 July, 1896, *Jepson 65m* (G and Calif.); Sebastopol, Mariposa Co., 4 July, 1897, *Congdon* (Calif.); Aqua Fria, Mariposa Co., 20 June, 1897, *Congdon* (Calif.); Mariposa, Mariposa Co., 10 May–17 June, 1892; *Congdon* (Stanford); Haile Ranch, Mariposa Co., June-July, 1892, *Congdon* (Calif.); Bootjack Ranch, Mariposa Co., 9 May, 13–18 June, 1892, *Congdon* (Stanford); Green Gulch, Mariposa Co., 23 May, 1904, *Congdon* (M); Raymond, Fresno Co., 9 June, 1894, *Burnham* (Pomona); Squaw Valley to Dunlap, 17 May, 1907, *Jepson 2750* (Calif.); Raymond to Yosemite, 11 June, 1891, *Fritchey 9* (M); in burns, Ione, 1910, *K. Brandegee* (Calif.); Toll House, Fresno Co., 2050 ft. alt., 13 June, 1900, *Hall & Chandler 4* (Calif.); Shut-Eye Pass, Fresno Co., 6500 ft. alt., 15 July, 1912, *Abrams 4932* (Stanford); roadside, Pinehurst to Badger, 31 May, 1921, *Ottley 1405* (Wellesley and Cornell); Greenhorn Range, Kern Co., 2–10 June, 1904, *Hall & Babcock 5033* (Calif. and Stanford); Bear Mt., Tehachapi Range, 5500 ft. alt., 26 May, 1917, *Jepson 7181* (Calif.); Nelson, Middle Tule River, 4700 ft. alt., 27 June, 1912, *Jepson 4869* (Cornell, M, and Calif.); Halstead's Ranch to Davis, n. fork of Kaweah, 2000 ft. alt., 19 June, 1900, *Jepson 566* (Calif.).

78b. Var. **constrictus** Grant[1]

Stems mostly erect, viscid-villous with long brownish hairs; cauline leaves few with long internodes; flowers chiefly in a spike-like cluster at the tips of the stems; calyx 1.2–2.4 cm. long, teeth triangular, subulate, unequal, much constricted at the narrow throat; seeds reticulate.

Distribution: Sierra Nevada Mts. from Tulare Co. to Kern Co. and in the Coast Range Mts., California.

[1] **Mimulus subsecundus** Gray var. **constrictus** Grant, var. nov., caulis erectus, viscido-villosus; caulis foliis paucis, internodis longis, floribus fasciculatis ad apicem caulis; calycis dentibus 1.2–2.4 cm. longis, subulatis, constrictis ad fauci angustato.—Collected in a field in the Middle Tule River, 3000–4000 ft. alt., April–Sept., 1897, *C. A. Purpus 5070* (U. S. Nat. Herb., Mo. Bot. Gard. Herb. no. 106700, TYPE, and Univ. Calif. Herb.).

Specimens examined:

California: fields on the Middle Tule River, 3000–4000 ft. alt., Apr.–Sept., 1897, *Purpus 5070* (M, TYPE, U. S., and Calif.); Pine Flat, near Calif. Hot Springs, Tulare Co., 20 June, 1917, *Moxley 582* (Cornell); near Guerilla Flat, vicinity of Poso Creek Valley, Kern Co., 9 July, 1895, *Dudley 566* (Stanford); southeastern California, Apr.–Sept., 1897, *Purpus 5305* (Calif.); top, Mt. Diablo, July, 1917, *Davidson 3279* (Davidson).

79. M. decurtatus Grant[1]

Glandular-pubescent plants; stem slender, 5–10 cm. high, simple or branched from the base; leaves obovate to spatulate, .7–2 cm. long, 3–6 mm. wide, thin, entire or denticulate along the upper margin, tapering to a narrow sessile base, lower leaves petioled; pedicels slender, 2–3 mm. long; calyx in anthesis broadly campanulate, 8–9 mm. long, villous with yellowish hairs, inflated when mature, teeth broadly triangular-obtuse, very short, subequal, throat oblique, slightly or not at all constricted; corolla 1–1.2 cm. long, reddish-purple to rose-pink, tube included, throat barely exserted, funnelform, lobes short, equal, somewhat spreading; upper pair of stamens and style slightly exserted, anthers glabrous; stigma-lips unequal, upper broadly obovate, lower very short, almost obsolete; capsule lanceolate, acute, included; seeds oblong, apiculate at each end, reticulate.

Distribution: known only from the type locality.

Specimens examined:

California: Ben Lomond, Santa Cruz Co., June, 1903, *Elmer 4519* (U. S., M, TYPE, Calif. Acad., Stanford, and Pomona); N. A. Pacific Coast Flora, 1887, *Parry* (M).

80. M. Rattani Gray in Proc. Am. Acad. **20**: 307. 1885; Syn. Fl. N. Am. ed. 2, **2**[1]: Suppl. 444. 1886.

[1] **Mimulus decurtatus Grant, sp. nov., annuus glanduloso-pubescens; foliis obovatis spatulatisve, .7–2 cm. longis, 3–6 mm. latis; fructifero calyce inflato, 8–9 cm. longo, dentibus brevibus, late triangulari-obtusis, fauce obliquo; corolla 1–1.2 cm. longa, rubro-purpurea roseave, laciniis inaequalibus, brevibus; antheris glabris; stigmatis laciniis inaequalibus.—Collected at Ben Lomond, Santa Cruz Co., June, 1903, *A. D. E. Elmer 4519* (U. S. Nat. Herb., Mo. Bot. Gard. Herb. no. 106684, TYPE, Calif. Acad., Stanford Univ. Herb., and Pomona Coll. Herb.).**

Eunanus Rattanii Greene in Bull. Calif. Acad. Sci. **1**: 105. 1885.

A densely glandular-pubescent plant; stem 4–15 cm. long, reddish, simple or mostly branched from the base; leaves few, sessile, oblong to oblanceolate, .8–2 cm. long, 2–3 mm. wide, entire or obscurely denticulate, basal leaves forming a small rosette, upper leaves bract-like; flowers numerous, crowded toward the ends of the stems; pedicels 1–3 mm. long; calyx viscid, broadly campanulate, rarely constricted at the oblique orifice, 5–6 mm. long, mature calyx broadly oval, 7–8 mm. long, 4–5 mm. broad, teeth 1–1.5 mm. long, triangular, mostly obtuse; corolla reddish-purple, marcescent, pubescent on the outside, 8–9 mm. long, tube included, throat narrowly funnelform, little exserted, lobes short, erect, truncate, nearly equal; upper pair of stamens exserted, glabrous; style exserted, stigma-lips unequal, the lower lip very short, sometimes almost obsolete; capsule firm, much exserted, lanceolate, attenuate, the apex often incurved; seeds oval or oblong, apiculate at both ends, papillate.

Distribution: in the Sierra Nevada Mts. and Coast Ranges, California. Rarely collected.

Specimens examined:

California: mountains of Colusa Co., under *Adenostema* bushes, June, 1884, *Rattan* (G, TYPE, and Calif.); near summit of Mt. Tamalpais, 3 July, 1886, *Curran* (G and Calif.); Ben Lomond, Santa Cruz Co., 1888, *Parry* (M); Boulder Creek, Santa Cruz Co., 1888, *Parry* (M); Mt. Diablo, 30 May, 1915, *Eastwood 4542* (Calif. Acad.).

81. **M. Torreyi** Gray in Proc. Am. Acad. **11**: 97. 1876; Bot. Calif. **1**: 565. 1876; Syn. Fl. N. Am. 2^1: 275. 1878, ed. 2, and Suppl. 445. 1886; Hall, Yosemite Fl. 224. 1912. Pl. 10, fig. 16.

Eunanus Torreyi Greene in Bull. Calif. Acad. Sci. **1**: 104. 1885.

Eunanus Fremontii Gray in Pac. Rail. Rept. **6**: 83. 1857, not Benth.

Glandular-pubescent plants; stem erect, .5–3.5 cm. high, simple or branched; leaves scattered, obovate, oblong or spatulate, 1.5–3.5 cm. long, .3–1.2 cm. broad, tapering to a slender petiole, obtuse, entire or with a few scattered teeth, often reddish on the lower surface, internodes usually much longer than the leaves;

pedicels 2–3 mm. long; calyx 7–8 mm. long, campanulate, weakly angled, scarious at the base and below the sinuses, throat somewhat oblique, teeth very short, unequal, obtuse, broadly triangular, the upper one slightly larger; corolla bilabiate, 1.8–2.2 cm. long, rose-red or pink, usually with two club-shaped white or yellowish patches, bordered with dark reddish-purple below the lower lip, tube little longer than the calyx, pubescent externally, yellowish, the lower side heavily spotted with red, abruptly expanding to a broad ventricose throat, lobes short, broad, truncate, upper lip shorter than the lower, the middle lobe of the lower lip often emarginate; stamens and style included, white, the stigma-lobes unequal, broadly peltate-funnelform; capsule often slightly exserted, lanceolate, obtuse, 8 mm. long, straight or slightly curved, both forms often occurring on the same plant; seeds broadly oval.

Distribution: common in dry open gravelly places in the foothills of the Sierra Nevada Mts., California.

Specimens examined:

California: Plumas Co., 29 July, 1855, *Newberry* in Williamson's Exp. (G, TYPE); Prattville, Plumas Co., 11 July, 1907, *Heller & Kennedy 8819* (M and Stanford); Prattville, 4500 ft. alt., 5 July, 1897, *Jones* (M); Sierras in Plumas Co., 1891, *Platt* (Calif.); Spanish Peak, above Buck's Ranch, Plumas Co., Aug., 1911, *Eggleston 7677* (U. S.); Meadow Valley, Plumas Co., 4000 ft. alt., 29 June, 1912, *H. M. Hall 9298* (R. Mt.); pine flats, Warner Valley, Plumas Co., 5000 ft. alt., *Jepson 4070* (Calif.); Colby, Butte Co., July, 1896, *Austin 162* (M); Chico Meadows, Butte Co., 4000 ft. alt., 22 June, 1914, *Heller* (M); Forest Ranch, Butte Co., 2700 ft. alt., 18 May, 1914, *Heller 11414* (M, Calif., and Stanford); near Stirling, Butte Co., 3525 ft. alt., 7 June, 1913, *Heller 10799* (M, Calif., and Stanford); De Sabla, Butte Co., June, 1917, *Edwards* (Stanford); Sugar Loaf Hill, Nevada City, 11 June, 1893, *Dudley* (Stanford); Bear Valley near Emigrant Gap, Nevada Co., 4500 ft. alt., 21 July, 1898, *Jepson 69m* (Calif.); near Donner Lake, 1865, *Torrey 370* (G); lower end of Donner Lake, Nevada Co., 6 Aug., 1903, *Heller 6870* (Phil., M, R. Mt., Calif., Stanford, and Pomona); near Placerville, Eldorado Co., 3200 ft.

alt., 12 Sept., 1915, *Heller 12271* (Cornell, M, and Stanford); waste ground, Truckee, 27 June, 1884, *Sonne 271* (M and Stanford); Lake Tahoe, 1 Aug., 1891, *Evans* (M); near Lake Tahoe, 31 Aug., 1872, *Redfield 247* (M); Fallen Leaf Lake near Lake Tahoe, 6700 ft. alt., July, 1906, *J. H. Thompson* (Stanford); Eldorado Co., 1866, *Rattan* (Stanford); Ham's, Amador Co., 5000 ft. alt., May, 1895, *Hansen 1125* (M and Stanford); Grass Valley, Amador Co., 3000 ft. alt., May, 1895, *Hansen 1124* (M and Stanford); Big Trees, Calaveras Co., 4700 ft. alt., 8 June, 1917, *A. L. Grant 963* (G, Cornell, N. Y., M, R. Mt., Ore., Calif., and Pomona); near Gardner, Calaveras Co., Aug., 1903, *Hall & Chandler 4782* (R. Mt. and Calif.); near Ranger's Cabin, Hog Ranch, Tuolumne Co., 11 June, 1916, *A. L. Grant 850* (M, Calif., and Stanford); Hog Ranch, Tuolumne Co., 16 June, 1917, *A. L. Grant 969* (G, U. S., Cornell, Phil., M, Ore., and Pomona); Hog Ranch to Crocker's, Yosemite Park, 4500 ft. alt., 3 Aug., 1911, *Jepson 4635* (Calif.); near Mariposa Big Trees, 6000 ft. alt., 22 June, 1918, *A. L. Grant 1300* (Cornell, M, Stanford, and Calif.); Darrah, Mariposa Co., June and July, 1892, *Congdon* (Calif. and Stanford); Wawona, Yosemite Route, 19 June, 1891, *Fritchey 69* (M); Clark's Ranch to Peregoy's, Yosemite Park, 1872, *Gray* (G); Fish Camp, Mariposa Co., 29 June, 1919, *Jepson 8396* (M and Calif.); Pine Ridge, Fresno Co., 5300 ft. alt., 15–25 June, 1900, *Hall & Chandler 64* (M and Stanford).

Although the type of *M. Torreyi* was collected in Plumas Co. by Newberry on Williamson's Expedition, the plant was named for Dr. Torrey, who secured abundant material near Donner Lake.

82. **M. Layneae** (Greene) Jepson, Fl. W. Mid. Calif. 405. 1902, and ed. 2, 378. 1911. Pl. 9, fig. 4.

Eunanus Layneae Greene in Bull. Calif. Acad. Sci. **1**: 104. 1885.

Stem slender, more or less reddish, simple or often freely branched, densely glandular-pubescent, usually somewhat nigrescent; leaves narrowly oblong or linear, 1–2.5 cm. long, 2–6 mm. broad, acute, entire or slightly toothed, tapering to a

slender, mostly sessile base, the lower sometimes short-petioled, frequently reddish on the lower surface; pedicels slender, reddish, 1–2 mm. long; calyx 5–7 mm. long, campanulate, becoming somewhat inflated and strongly ribbed when mature, slightly constricted at the oblique orifice, teeth triangular, acute or subulate, 1–2 mm. long, reflexed; corolla rose-red to reddish-purple, streaked down the throat, 1.5–2.2 cm. long, more or less pubescent externally, tube exserted, usually less than twice as long as the calyx, throat funnelform, dark reddish-purple, with one or two white or yellow patches generally bordered with dark red and spotted with red below the lower lip, lobes subequal, not widely spreading, truncate, often slightly emarginate and with rounded sinuses; stamens included, anthers hispid; style included, stigma-lobes broadly ovate, rounded, the lower scarcely more than half the length of the upper lobe; capsule usually exserted, 9–11 mm. long, lanceolate with an obtuse, mostly incurved slender apex; seeds oval, apiculate at both ends, tuberculate and faintly ribbed.

Distribution: dry sandy places, often growing in large patches, in the North Coast Range and Sierra Nevada Mts., from Siskiyou Co. to Fresno Co., California.

Specimens examined:

California: Dunsmuir, Siskiyou Co., 2200 ft. alt., 14 August, 1914, *Jepson 6169* (Calif.); Igerna, Siskiyou Co., 5 April, 1903, *Copeland*, distributed as *C. F. Baker 3851* (Stanford and Pomona); near Sisson, 3555 ft. alt., 1–10 June, 1897, *H. E. Brown 303* (M); dry land, Goosenest at Sisson's, base of Mt. Shasta, 21 Aug., 1880, *Engelmann* (M); Goosenest foothills, Siskiyou Co., 5000 ft. alt., 19 June, 1910, *Butler 1585* (M, R. Mt., and Stanford); near Edgewood, Siskiyou Co., 28–31 July, 1892, *Edw. Palmer 2603* (U. S.); near Shasta Springs, 5 June, 1905, *Heller 7963* (M), Squaw Creek Ranger Station, Shasta Co., June, 1916, *Drew* (Stanford); Shasta Springs, Aug., 1894, *Jepson 36m* (Calif.); between forks of Trinity, June, 1883, *Rattan* (Stanford, *type collection*); Horseshoe Bend above Shasta Springs, July–Aug., 1894, *Jepson 34m* (Calif.); hill slopes of Mad River Valley, 6 miles above Ruth, Trinity Co., 3000 ft. alt., 24 June, 1913, *Tracy 4320* (G, M, R. Mt., and Calif.); region of Lassen's Peak, Aug., 1891,

Chestnut & Drew (Calif.); near Redding, 18 June, 1914, *McMurphy* (Stanford); Valley of Trinity River, near mouth of Willow Creek, Humboldt Co., 500 ft. alt., 8 July, 1911, *Tracy 3443* (G and Calif.); between Sisson's and Sims, 24 July–10 Aug., 1894, *Jepson 71m* (Calif.); Shasta Co., 1887, *Parry* (M); Red Mt., s. e. Mendocino Co., 18 June, 1908, *Jepson 3037a* (M and Calif.); Burnt Ranch, Humboldt Co., June, 1883, *Rattan* (G); between Mud Flat and Bennett Spring on the Newville-Covelo Road, Glenn Co., 2500 ft. alt., 3 June, 1915, *Heller 11919* (M and Stanford); Bartlett Mt., Lake Co., 1884, *K. Brandegee* (Calif.); near Bartlett Springs, Aug., 1916, *Stinchfield* (Stanford); Indian Valley, near Lake Co., 24 May, 1920, *Jepson 9000* (Calif.); Howell Mt., Napa Co., 26 June, 1893, *Jepson 35m* (Calif.); in chaparral, Howell Mt., Napa Co., 1400 ft. alt., 19 May, 1902, *Tracy 1544* (U. S. and Stanford); Auburn, Placer Co., 3 April, 1894, *Congdon* (Calif.); Italian Bar, near Columbia, Tuolumne Co., 2000 ft. alt., 5 June, 1915, *A. L. Grant* (M and Stanford); Hog Ranch above Hetch-Hetchy Valley, 14 June, 1917, *A. L. Grant 968* (G, Cornell, U. S., N. Y., Phil., M, R. Mt., Ore., Calif., Stanford, and Pomona); Little Yosemite, 6300 ft. alt., 5 July, 1909, *Jepson 3142* (Calif.); growing in sandy soil, often forming large patches, Little Yosemite Valley, 7 July, 1911, *H. M. Hall 9056* (G, R. Mt., Stanford, and Pomona); Snow Creek, Yosemite, 7100 ft. alt., 6 Aug., 1916, *Smiley 669* (G); Yosemite, 5500 ft. alt., 1 July, 1911, *Abrams 4584* (Stanford); Tamarack Flat, Yosemite, 6390 ft. alt., 14 July, 1911, *Abrams 4694* (G and Stanford); Upper San Joaquin, Madera Co., 17 Aug., 1895, *Congdon* (Stanford); Chihuahua Falls, Mariposa Co., 12 Aug., 1895, *Congdon* (G); near Jackass Meadows, Madera Co., 17 Aug., 1895, *Congdon* (G); Pine Ridge, Fresno Co., 5300 ft. alt., 15–25 June, 1900, *Hall & Chandler 208* (M and Stanford); Beasore Meadow, Mariposa Co., 24 July, 1918, *A. L. Grant 1310* (Phil., Cornell, M, and Calif.); Mono Hot Springs, Fresno Co., 6300 ft. alt., 3 Aug., 1918, *A. L. Grant 1494* (M and Calif.); near Peregoy Meadow, Yosemite National Park, 7000 ft. alt., 21 June, 1918, *A. L. Grant 1296* (Calif.); Alder Creek Trail, Yosemite Park, 5500 ft. alt., 1 July, 1911, *Jepson 4327* (Calif.);

abundant in sandy spots, trail to Dinkey Grove of Big Trees, near Dinkey Station, Fresno Co., 5500 ft. alt., 29 July, 1917, *A. L. Grant 1200* (M and Calif.); in dry sandy places, often in large patches, Huntington Lake, Fresno Co., 7000 ft. alt., 21 July, 1918, *A. L. Grant 1458* (G, M, and Calif.); Huntington Lake, Fresno Co., 7000 ft. alt., 5 July, 1917, *A. L. Grant 1041* (Cornell, M, and Calif.); Huntington Lake, Fresno Co., 7000 ft. alt., 16 July, 1917, *A. L. Grant 1102* (G, Cornell, Phil., M, R. Mt., Calif., Stanford, Ore., and Pomona); Arnold Meadow, Madera Co., 26 July, 1918, *A. L. Grant 1356* (Cornell, M, and Calif.); King's Cañon bed, King's River Cañon and Kearsarge Pass, Sierra Nevada, 5–15 July, 1900, *Jepson 775* (Calif.).

This species is so closely related to *M. Torreyi* that it is not always easy to separate them by the shape of the calyx-teeth and capsule, as Greene suggested when he described *M. Layneae*. Typical specimens of *M. Torreyi* have blunt calyx-teeth but sometimes calyces with blunt teeth or acute teeth are found on the same plant. The most constant characters for separating the two species are found in the corolla, *M. Layneae* having a slender, much exserted reddish-purple corolla-tube and a narrow throat, whereas *M. Torreyi* has a little exserted, yellowish or pink corolla-tube with a broad, somewhat ventricose throat and pink or rose-pink lobes. The specimens of *M. Layneae* from northern California have densely pubescent corolla-tubes, and those from central California are sometimes nearly glabrous.

83. **M. nanus** Hook. & Arn. Bot. Beechey's Voyage, 378. 1840; Gray in Proc. Am. Acad. **11**: 96. 1876; Bot. Calif. **1**: 564. 1876; Syn. Fl. N. Am. **2**^{1}: 274. 1878, ed. 2, excl. the yellow-flowered plant, and Suppl. 444. 1886; Piper, Contr. U. S. Nat. Herb. **11**: 508. 1906; Nelson in Coulter & Nelson, Manual Cent. Rocky Mountains, 453. 1909; Hall, Yosemite Fl. 224. 1912.

M. nanus α pluriflorus Hook. & Arn. Bot. Beechey's Voyage, 378. 1840.

Eunanus Tolmei Benth. DC. Prodr. **10**: 374. 1846; Greene in Bull. Calif. Acad. Sci. **1**: 103. 1885; Howell, Fl. Northwest Am. 518. 1903; Rydb. Fl. Rocky Mountains, 780. 1917.

Eunanus nanus Holzinger, Contr. U. S. Nat. Herb. **3**: 244. 1895.

Small leafy plants, viscid-puberulent or sometimes densely glandular-pubescent, 5–15 cm. high, usually freely branched from near the base, branches low and spreading; stems mostly straw-colored, occasionally more or less tinged with red; leaves obovate to oblong, 1–3 cm. long, 2–6 mm. broad, acute or obtuse, thin, entire, 1–3-nerved, lower leaves larger and somewhat spatulate, tapering to a distinct petiole; flowers abundant, pedicels slender, 2–3 mm. long; calyx tubular-campanulate, 7–8 mm. long, scarious below the sinuses, throat slightly if at all oblique, not constricted, teeth nearly equal, triangular-acute, about one-fourth as long as the tube; corolla bilabiate, 1.7–2 cm. long, reddish-purple, puberulent outside, tube yellowish, slender, exserted, about twice as long as the calyx, throat funnelform with two hairy white or yellow patches dotted with red below the lower lip and irregular darker reddish-purple areas below the upper lip, lobes unequal, sinuses broad, rounded, upper lip more or less erect and longer than the lower one; anthers hispid, filaments of the longer pair of stamens sometimes puberulent; style and upper pair of stamens slightly exserted, stigma-lobes nearly equal, peltate-funnelform, ciliate; capsule in general slightly exceeding the calyx, ovate, obtuse; seeds oval, reticulate, apiculate at each end.

Distribution: common in open sandy places in the Rocky Mountains and in the Pacific Coast States.

Specimens examined:

Montana: in dry ground, Madison Basin, Gallatin Co., 23 June, 1899, *Nelson & Nelson 5494* (R. Mt.).

Wyoming: Fire Hole, Yellowstone Park, July, 1904, *Oleson 14*, (R. Mt.); Lower Basin, Yellowstone Park, 15 July, 1906, *Cooper 61y* (R. Mt.); on sandy or gravelly open flats, Upper Geyser Basin, 31 July, 1899, *Nelson & Nelson 6256* (Cornell, M, R. Mt., and Pomona); Yellowstone Park, 9 Aug., 1885, *Letterman 116* (M); ant hills, Henry's Fork, Snake River, 5400 ft. alt., 19 June, 1860, *Hayden* (M).

Colorado: Graymont, without date, *Letterman* (M).

Idaho: grows only on ant hills, Shoshone Flat, Minidoka National Forest, 6300 ft. alt., 3 Aug., 1913, *Crockett 29* (R. Mt.); Lake

Waha, Nez Perces Co., 3500–4000 ft. alt., 25 June, 1896, *Heller & Heller 3324* (M); Corral, Blaine Co., 28 June, 1916, *Macbride & Payson 2930* (R. Mt. and M); Martin, Blaine Co., 5 July, 1916, *Macbride & Payson 3049* (M and R. Mt.); sandy gravelly slopes, Falk's Store, Canyon Co., 17 May, 1910, *Macbride 59* (M, R. Mt., Calif., and Stanford); sandy slopes, Silver City, Owyhee Co., 15 June, 1910, *Macbride 402* (M and R. Mt.); Indian Gulch, 18 June, 1892, *Mulford* (M); Ketchum, 25 June, 1892, *Mulford* (M); gravelly bench lands, Ketchum, Blaine Co., 20 July, 1911, *Nelson & Macbride 1227* (R. Mt.); Sawtooth National Forest, 1910, *Woods 42a* (R. Mt.); dry hills, Boise River, 27 July, 1911, *Clarke 162* (R. Mt.).

Nevada: Little Lakes Canyon, Elko Co., 21 July, 1902, *Kennedy 598* (R. Mt.); Eagle Valley, Ormsby Co., 7 June, 1902, *C. F. Baker 1024* (M and Pomona); near Holstein Ranch, north of Carson, 29 May, 1901, *Steinmetz* (Stanford).

Oregon: common in dry soil, eastern Oregon, 12 July, 1898, *Cusick 2152* (Cornell and M); hillsides of Ochoco Creek, Crook Co., 10 July, 1901, *Cusick 2655* (Cornell, M, and R. Mt.); vicinity of Laidlaw, Crook Co., 6 June, 1912, *Whited 48* (Ore.); common on plains, Bend, Crook Co., 8 May, 1905, *E. Nelson 797* (M and R. Mt.); Redmond, 15 May, 1916, *Jackson & Hammond* (Ore.); Camp Harney, 1875, *Bendire* (M); sandy woods along Klamath Falls, 21 July, 1920, *Peck 9628* (M); dry sandy ground, 10 miles from Crescent, Klamath Co., 19 July, 1920, *Peck 9577* (M).

California: near Old Chat, Lassen Co., 1 July, 1907, *Heller & Kennedy 8673* (Phil., M, and Stanford); Yollo Bolley Mts., July, 1897, *Jepson 37m* (Calif.); Hobart Mills, 29 May, 1917, *Wagner* (Stanford).

84. **M. Austinae** (Greene) Grant, comb. nov.
Eunanus Austinae Greene, Pittonia **1**: 36. 1887.

A mostly glandular-puberulent plant, sometimes glandular-pubescent; stem 5–9 cm. long, freely branched from the base; leaves numerous, clustered with the flowers toward the ends of the stem and branches, spatulate or elliptical, 1.2–2 cm. long, 3–4 mm. wide, tapering to a short, slender petiole, entire; calyx

7–8 mm. long, not distended by the mature capsule, teeth unequal, triangular-acute, about one-third as long as the tube; corolla funnelform, bilabiate, yellow, more or less streaked with red down the throat, tube about 1½ times as long as the calyx, throat short, narrow, lobes unequal; stamens included, anthers hispid; style exserted, the stigma-lips equal, broadly peltate-funnelform; capsule lanceolate, attenuate, exserted; seeds oblong, reticulate.

Distribution: mountains of northern California.

Specimens examined:

California: Pine Creek, Modoc Co., 1893, *Austin* (Stanford); Modoc Co., July, 1895, *Austin 16* (Pomona); Big Valley, Lassen Co., 20 June, 1894, *Baker & Nutting* (Calif.).

According to Dr. Greene, *M. Austinae* does not have the skunk-like odor of *M. mephiticus.*

85. **M. clivicola** Greenm. in Erythea 7: 119. 1899; Piper & Beattie, Fl. Southeast. Wash. & Adj. Idaho, 227. 1914.

Eunanus clivicola Heller in Muhlenbergia 1: 60. 1904.

Glandular-pubescent plants; stem 5–15 cm. high, mostly simple; leaves scattered, oblong or obovate to oblanceolate, 1–2.5 cm. long, 4–8 mm. broad, entire or occasionally toothed toward the upper end, tapering to a slender sessile base, mostly 1-nerved; flowers scattered, pedicels slender, 3–7 mm. long; calyx campanulate, 8–10 mm. long, narrowed at the base, flaring abruptly to a wide-open slightly oblique throat at maturity, scarious between the green ribs, teeth broadly triangular-acute, ciliate, nearly equal, 1–1.5 mm. long; corolla funnelform, somewhat bilabiate, 1.4–2 cm. long, tube yellowish, slightly exserted, throat reddish-pink with a large yellow patch, spotted with red below the lower lip, lobes reddish-pink, streaked with darker reddish-purple, spreading, rounded, with broad sinuses; stamens included, the anthers sparsely hispid; style frequently as long as the throat, stigma-lips equal; capsule linear-lanceolate, exserted, incurved at the apex; seeds favose-areolate, apiculate at both ends, oval, less than twice as long as broad.

Distribution: hillsides in southwestern Idaho, Washington, and Oregon.

Specimens examined:

Idaho: slopes near the foot of Weissner's Peak, Kootenai Co., 5–7 July, 1892, *Sandberg, MacDougal & Heller 586* (G, TYPE, and Phil.); dry hillsides of Cedar Mts., Latah Co., 7 July, 1893, *Piper 1657* (G and Stanford); Lake Waha, 26 June, 1894, *Henderson 2677* (G, Cornell, and R. Mt.).

Oregon: moist gulch of North Pine Creek, near Snake River, 13 July, 1899, *Cusick 2236* (G, Cornell, F, M, R. Mt., and Calif.); hills near Snake River, 25 May, 1898, *Cusick 1891*, (Cornell and M); Deshut's Bridge, 19 June, 1885, *Howell* (Ore. and Calif.).

86. **M. angustifolius** (Greene) Grant, comb. nov.

Eunanus angustifolius Greene, Pittonia **2**: 23. 1889.

A glandular-pubescent annual; stem red, 4–10 cm. high, mostly branched; leaves numerous, linear or oblanceolate, 1–1.7 cm. long, 1–3 mm. wide, sessile, entire, crowded and often with smaller leaves fascicled in the lower axils; calyx cylindrical, scarious between the red ribs, teeth triangular-lanceolate, fully one-third as long as the calyx, spreading very little at the oblique orifice; corolla bilabiate, narrowly funnelform, sparsely pubescent on the outside, reddish purple, 1.3–1.7 cm. long, the tube exserted, lobes unequal, those of the upper lip about half as long as the lower; stamens slightly exserted, glabrous; stigma-lobes unequal; capsule lanceolate, about as long as the calyx, opening to the base along both sutures.

Distribution: known only from Washoe Mts., Nevada, the type locality.

Specimens examined:

Nevada: on trail from Bronco to Mt. Rose, western slope of Washoe Mts., July, 1889, *Sonne 14* (Greene, TYPE, and Calif.); Mt. Rose, Washoe Co., 9500 ft. alt., 26 Aug., 1911, *Heller 10343* (G and Stanford).

87. **M. densus** Grant[1]

A more or less densely glandular-pubescent and viscid plant, sometimes viscid-villous; stem mostly profusely branched, 5–15

[1] **Mimulus densus** Grant, sp. nov., herba plus minusve dense glanduloso-pubescens; caule profuse ramoso, 5–15 cm. alto; foliis ellipticis, linearibus oblongisve; calyce

cm. high; leaves numerous, elliptical, linear or occasionally oblong, 1.5–2.5 cm. long, 2–5 mm. broad, tapering to a slender sessile base; flowers axillary, numerous, pedicels 2–5 mm. long; calyx open-campanulate, 6–10 mm. long, not distended by the mature capsule, teeth deltoid-acute to subulate, unequal, about one-fourth as long as the tube, throat oblique; corolla funnelform, 1.7–2 cm. long, yellow, more or less streaked and tinged with red or sometimes wholly red, tube slender, about twice as long as the calyx, throat short, expanded, lobes spreading, somewhat quadrangular, subequal, a hairy region below the lower lip and with scattered hairs around the throat; upper pair of stamens sometimes exserted, anthers hispid; style exserted, stigma-lobes broadly peltate-funnelform, unequal; capsule lanceolate to ovate-lanceolate, more or less attenuate, as long as or, more commonly, exceeding the calyx; seeds oblong, apiculate at both ends.

Distribution: central and western Nevada and east of the Sierra Nevada Mts., from Inyo Co. north to Lassen Co., California.

Specimens examined:

Nevada: hills around Austin, Lander Co., Toiyabe Range, 6400 ft. alt., 21–25 July, 1913, *Kennedy 4401* (M, TYPE, and Stanford); between Austin and Big Creek, Lander Co., 6000 ft. alt., 27 July, 1913, *Kennedy 4091* (Stanford); Tonopah, 6000 ft. alt., June, 1907, *Shockley 84* (Calif. and Stanford); Miller Mt., Esmeralda Co., 7000 ft. alt., *Shockley 111* (Stanford).

California: Campito Meadow, White Mts., 11000 ft. alt., 27 July, 1917, *Jepson 7305* (Calif.); Black Canyon, White Mts., 7 July, 1891, *Coville & Funston 1792* (Stanford); Indian Valley Grade, July, 1896, *Bruce 847* (M); near the river, Portola, Plumas Co., 30 July, 1911, *K. Brandegee* (Calif.); Pine Creek, Lassen Co., 12 July, 1894, *Baker & Nutting* (R. Mt.); near Old Chat, Lassen Co., 1 July, 1907, *Heller & Kennedy 8672* (M and Stanford); Truckee, Nevada Co., 15 Aug., 1903, *Heller 7173* (M and Pomona).

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lato-campanulato, dentibus inaequalibus; corolla 1.7–2 cm. longa, flava, plus minusve rubro-colorata, aliquandro rubra, tubo calyce duplo longiore; antheris hispidis; capsula lanceolata.—Collected in the hills around Austin, Lander Co., Toiyabe Range, 6400 ft. alt., 21–25 July, 1913, *P. B. Kennedy 4401* (Mo. Bot. Gard. Herb. no. 715524, TYPE, and Stanford Univ. Herb.).

This is a different-looking plant from *M. mephiticus* with which it has been confused. The structural characters are similar but *M. densus* has a different kind of pubescence, the plant is ranker in growth, freely branched from the base, and the stems are generally crowded with leaves and flowers. The capsule is usually attenuate, more or less exserted, and varies in shape from ovate-lanceolate, not much stouter than that of *M. mephiticus*, to distinctly lanceolate, the latter being the more common form. The color is not at all constant; the corolla in the type and *Jepson 7305* is yellow with a few reddish-brown markings; in *Heller & Kennedy 8672* the tube and throat are red, whereas the plants collected by Mrs. Bruce on the Indian Valley Grade, by *Kennedy 4401* and *4091*, and *Heller 7173*, have dark red flowers.

88. **M. mephiticus** Greene in Bull. Calif. Acad. Sci. **1**: 9. 1884; Gray, Syn. Fl. N. Am. ed. 2, 2^1: Suppl. 444. 1886; Smiley in Univ. Calif. Publ. Bot. **9**: 334. 1921.

Eunanus mephiticus Greene in Bull. Calif. Acad. Sci. **1**: 102. 1885.

Stems erect, 4–12 cm. high, simple or branched, the whole plant more or less glandular-pubescent and viscid; leaves elliptical, oblanceolate or nearly linear, 1–2 cm. long, 2–5 mm. broad, obtuse or acute, entire, generally tapering to a short petiole; flowers appearing in the lowest axils but mostly clustered with the leaves toward the tips of the stems, pedicels slender, 2–4 mm. long; calyx open-campanulate, 4–6 mm. long, scarious below the sinuses and distended by the mature capsule, teeth lanceolate, acute or sometimes subulate, unequal, usually one-fourth the length of the tube, throat oblique; corolla funnelform, 1.2–1.8 cm. long, yellow, rarely reddish-purple, the slender tube at least 1½ times as long as the calyx, throat broad, more or less tinged, spotted or streaked with reddish-brown, lobes nearly equal, subquadrate, with broad rounded sinuses; stamens and style usually included, rarely slightly exserted, anthers hispid, filaments with retrorse hairs at the base of the longer pair; stigma-lobes broadly peltate-funnelform, subequal or occasionally equal; capsule lanceolate, obtuse, as long as the distended calyx, more often exserted; seeds oval, less than half as long as broad, apiculate at both ends, reticulate.

Distribution: common in open woods and sandy places in the Sierra Nevada Mts., from Amador Co. to Fresno Co., California. Odor strongly mephitic.

Specimens examined:

California: Pedlar, Amador Co., 6500 ft. alt., July, 1892, *Hansen 463* (M and Stanford); moist sandy spots, Strawberry Lake near the dam, Tuolumne Co., 5500 ft. alt., 10 June, 1917, *A. L. Grant 956* (M); Cottonwood Trail, Hetch-Hetchy Valley, 6500 ft. alt., 15 June, 1918, *A. L. Grant 1270* (Cornell, M, and Calif.); Yosemite, July, 1884, *Hutchings* (G); above Yosemite, *Dix* (G); growing in sandy soil, often forming large yellow beds, Little Yosemite Valley, 7 July, 1911, *H. M. Hall 9055* (M, R. Mt., Stanford, and Pomona); Lake Merced, Yosemite Park, 7200 ft. alt., 10 July, 1909, *Jepson 3214a* (Calif.); Tamarack Flat, Yosemite Park, 6390 ft. alt., 14 July, 1911, *Abrams 4695* (Stanford); at Peregoy's, 1872, *Gray* (G); near Peregoy Meadow, Yosemite Park, 7200 ft. alt., 21 June, 1918, *A. L. Grant 1298a* (Cornell and M); King's River Cañon, Fresno Co., 15 June, 1921, *Ottley 1487* (Wellesley and M); granite sand between Rowell and Sunset Meadows, King's River Region, Fresno Co., Aug., 1904, *Dudley* (Stanford); South Fork Kaweah Crossing near Sand Meadow, Sequoia Park, 8200 ft. alt., 14 Aug., 1911, *Jepson 4674* (Cornell, M, and Calif.); Round Meadow., Sequoia Nat'l. Park, 6500 ft. alt., 24 June–2 July, 1900, *Jepson 699* (M and Calif.); Hossack Creek, eastern Tulare Co., 7000 ft. alt., 12 July, 1908, *Hall & Hall 8346* (Calif.); Alta Meadows, 9000 ft. alt., Aug., 1905, *K. Brandegee* (G); Alta Meadows, Tulare Co., 19 July, 1919, *Newlon 1m* (Cornell, M, and Calif.); Hockett Meadows, Tulare Co., about 8500 ft. alt., 5 Aug., 1904, *Hall & Babcock 5622* (Calif. and Pomona); South Fork Middle Tule River, 5300 ft. alt., 28 June, 1912, *Jepson 4874* (M); Hockett's Meadow, Tulare Co., 22 July, 1904, *Culbertson 4410* (Calif., Stanford, and Pomona); Little Kern River, Tulare Co., July, 1904, *Hall & Babcock 5405* (Stanford); brook one mile above Parson's Mill, Poso Creek Valley, 9 July, 1895, *Dudley 590* (Stanford); plains, Little Kern River, 6000–7000 ft. alt., July, 1895, *Purpus 1383* (Calif.); sandy plains, Trout Meadows, July, 1895, *Purpus 1389* (Calif.).

89. M. coccineus Congdon in Erythea 7: 187. 1899.

Stems 2–6 cm. high, simple or branched, the whole plant glandular-puberulent; leaves oblanceolate to linear, .6–1 cm. long, 2–3 mm. broad, entire, mostly obtuse, tapering to a slender petiole, the lower often spatulate; flowers clustered at the tips of the stems, pedicels rarely over 1 mm. long; calyx cylindrical, 3–5 mm. long, expanded by the mature capsule and faintly ribbed, throat oblique, teeth unequal, linear, subulate, one-third to one-half as long as the tube; corolla funnelform, 1.6–2 cm. long, deep reddish-purple, the throat usually with one or two lighter areas below the lower lip, tube slender, 2–3 times as long as the calyx, limb expanded, .5–1.2 cm. wide, the lobes subequal, withering almost filiform; stamens mostly included, the anthers hispid; style slightly exserted, the lobes subequal; capsule broadly ovate, acute, slightly exceeding the calyx; seeds smooth.

Distribution: in granite sand at high altitudes in the southern Sierra Nevada Mts. Not often collected.

Specimens examined:

California: Glacier Point Turnpike, Mariposa Co., 22 July, 1891, *Congdon* (Calif. and Stanford); Hockett's Meadow, 8600 ft. alt., 22 July, 1904, *Culbertson*, distributed as *C. F. Baker 4411* (M and Pomona); between Rowell Meadow and Sunset Meadow, King's River Region, Fresno Co., Aug., 1904, *Dudley* (Stanford); Coyote Pass Trail, Milky Meadow to Three Rivers, 25–31 July, 1900, *Jepson 979* (Calif.); Marble Mt., 6 July, 1907, *Jepson 2846* (Calif.); N. Fork of Middle Tule River, 8500 ft. alt., 15 Aug., 1911, *Jepson 4688* (Calif.).

This species was first collected by Congdon near the mountain tops of the Sierras, east of the Minaret's.

90. M. stamineus Grant[1]

Plants 2–10 cm. high, freely branched from the base or occasionally simple, densely glandular-pubescent; leaves sessile,

[1] **Mimulus stamineus** Grant, sp. nov., herba, 2–10 cm. alta, dense glanduloso-pubescens; foliis sessilibus, anguste oblanceolatis ellipticisve, aliquando linearibus, obtusis; calyce 5–8 mm. longo, dentibus lanceolatis-subulatis; corolla rubro-purpurea, 1.2–2 cm. longa, lobis inaequalibus; antheris hispidis; capsula oblonga.—Collected in granite sand, summit of Sonora Pass, Tuolumne Co., 10000 ft. alt., 24 Aug., 1915, *Adele Lewis Grant 357* (Cornell Univ. Herb., Mo. Bot. Gard. Herb. no. 893571, TYPE, Univ. Calif. Herb., and Stanford Univ. Herb.).

numerous, narrowly oblanceolate to elliptical or sometimes linear, 1–2.5 cm. long, 2–5 mm. broad, obtuse, entire; flowers somewhat clustered toward the tips of the branches, numerous, axillary, pedicels 1–2 mm. long; calyx tubular, 5–8 mm. long, expanded by the mature capsule, teeth lanceolate-subulate, one-third to one-fourth the length of the tube, the lower smaller and shorter, throat oblique; corolla funnelform, reddish-purple, 1.2–2 cm. long, pubescent externally, tube slender, less than twice as long as the calyx, throat short, with a yellowish area spotted with red below the lower lip, the whole with long scattered club-shaped hairs, lobes broad, somewhat truncate, nearly equal, little spreading; stamens exserted, anthers hispid, filaments unequally inserted, the longer with retrorse hairs near the base; style exserted, stigma-lips unequal, rounded, broadly peltate-funnelform; capsule oblong, obtuse, usually about as long as the calyx or slightly exserted; seeds oblong, apiculate at each end.

Distribution: Washington, Nevada, and California.

Specimens examined:

Washington: Klickitat, June, 1879, *J. Howell* (G and M); Klickitat, 16 May, 1882, *Howell* (Ore.).

Nevada: King's Cañon, Ormsby Co., 5 June, 1902, *C. F. Baker 1010* (M and Pomona); Snow Valley, Ormsby Co., 27 July, 1902, *C. F. Baker 1375* (M, R. Mt., Calif., and Pomona); Miller Mt., Esmeralda Co., 7000 ft. alt., without date, *Shockley 301A* (Stanford).

California: Black Cañon, White Mts., Mono Co., 8 July, 1891, *Coville & Funston 1798* (Cornell, M, and Stanford); sandy field, Myers, Eldorado Co., 2 July, 1920, *Ottley 930* (Wellesley and M); near Deadman's Creek, Mono Co., 22 Aug., 1895, *Congdon* (Calif. and Stanford); dry valley floor near Mono Crater, Mono Co., 19 July, 1918, *Ferris 1464* (Stanford); growing in granite sand, summit of Sonora Pass, Tuolumne Co., 10000 ft. alt., 24 Aug., 1915, *A. L. Grant 357* (M, TYPE, Cornell, Calif., and Stanford); Campito Meadow, White Mts., 11000 ft. alt., 27 July, 1917, *Jepson 7304* (Calif.); Rock Creek near Mt. Whitney, 9600 ft. alt., 20 July, 1912, *Jepson 5057* (Calif.); Ramshaw Meadows, Kern Peak, 8600 ft. alt., 3 July, 1912, *Jepson 4957* (collected by *Haskell*) (Calif.); Kern River, 9850

ft. alt., Sept., 1875, *Rothrock 378* (G); Volcano Meadow, vicinity of Mt. Whitney, 8 Aug., 1897, *Dudley 2498* (Stanford); Whitney Meadows, 19 Aug., 1891, *Coville & Funston 1625* (Cornell, M, and Stanford); border of Whitney Meadow, 10300 ft. alt., Aug., 1897, *Dudley 2488* (Stanford); Milky Meadow, Tulare Co., 23–31 July, 1900, *Jepson 946* (Calif.); Olancha Mt., Tulare Co., 8000 ft. alt., June, 1904, *Hall & Babcock 5218* (M and R. Mt.).

91. **M. leptaleus** Gray in Proc. Am. Acad. **11**: 96. 1876; Bot. Calif. **1**: 564. 1876, in part; Syn. Fl. N. Am. **2**^{1}: 274. 1878, ed. 2, and Suppl. 445. 1886, in part.

Eunanus leptaleus Greene in Bull. Calif. Acad. Sci. **1**: 101. 1885.

Small plants, viscid-pubescent to almost glabrous, commonly 2–4 cm. high, occasionally 6–10 cm. high, the taller plants usually branched; stem slender, mostly reddish; leaves obovate, oblanceolate or linear, .5–1.5 cm. long, 1–3 mm. wide, thick, obtuse, rarely acute, 1-nerved, entire, tapering to a short slender petiole or the uppermost ones sessile, usually clustered with the flowers at the tips of the stems, often tinged with red and with a red midrib; pedicels almost filiform, 1–2 mm. long; calyx slender, cylindrical, usually more or less tinged with red, 3–4 mm. long, becoming distended and completely filled with the mature capsule, obscuring the angles, throat slightly oblique, teeth from one-third to one-half the length of the tube; corolla slender, funnelform, 8–10 mm. long, reddish-purple, tube exserted at least half the length of the calyx, throat beardless with a large yellowish or white patch spotted with red down the anterior part, lobes short, squarish, mostly equal, limb about 3 mm. in diameter, the whole withering persistent and becoming filiform; stamens included, not approximate, anthers reflexed, glabrous; style and stigma included, stigma-lobes very unequal, ovate, acute; capsule broadly oblong-ovate, obtuse, compressed, little longer than the calyx; seeds smooth, oval, apiculate at both ends, less than twice as long as broad.

Distribution: open gravelly places in the high Sierra Nevada Mts., California.

Specimens examined:

California: Lassen's Peak, Aug., 1896, *Bruce 423* (M); rocky meadow above Glen Alpine Springs, Eldorado Co., 18 June, 1920, *Ottley 786* (Wellesley and M); Mt. Tallac, Lake Tahoe Region, 9500 ft.alt., 25 Aug., 1909, *McGregor 191* (Stanford); Soda Springs, Nevada Co., 7000 ft. alt., 20 July, 1881, *Jones 2396* (G and M); southeastern approaches to Castle Peak, Nevada Co., 31 July, 1903, *Heller 7067* (Phil., M, R. Mt., Stanford, and Pomona); in open gravelly places, Sonora Pass, Tuolumne Co., 9600 ft. alt., 15 Aug., 1915, *A. L. Grant 279* (Cornell, M, Ore., Calif. Acad., and Stanford); Peregoy's, Clark's, etc., 1872, *Gray* (G, TYPE); Mono Trail, 10000 ft. alt., 1866, *Bolander 6016* (U. S.); Beasore Meadow, Madera Co., 7500 ft. alt., 24 June 1918, *A. L. Grant 1311* (Phil., Cornell, M, Calif., and Pomona); above Fresno Dome, Madera Co., 7000 ft. alt., 23 June, 1918, *A. L. Grant 1309a* (M); abundant in open spaces, trail to Nellie Lake, Fresno Co., 8000 ft. alt., 11 July, 1917, *A. L. Grant 1079* (M, G, N. Y., Cornell, U. S., Calif., and Stanford); Huntington Lake, Fresno Co., 7000 ft. alt., 27 July, 1918, *A. L. Grant 1481* (Phil., U. S., Cornell, M, R. Mt., Calif., and Pomona); trail to Mineral King, Upper Kaweah River, Tulare Co., 22 Aug., 1896, *Dudley 1717* (Stanford); Red Lake at foot of Red Mt., Fresno Co., 9000 ft. alt., 2 Aug., 1920, *A. L. Grant 1662a* (Cornell, M, and Pomona); North Fork of King's River, 7000 ft. alt., July, 1900, *Hall & Chandler 429* (M and Stanford); Upper Kaweah River, Tulare Co., 17 Aug., 1896, *Dudley 1663* (Stanford).

There seems to be much confusion as to what is really *M. leptaleus*, since in his description of this species Dr. Gray included what we now recognize as several distinct species. The original description reads "Gravelly soil in the Sierra Nevada, California, at 5000 ft. and upwards, south of the Yosemite, Miss Dix, A. Gray, and in Sierra County, Lemmon." According to our present methods of procedure, Miss Dix's specimen would be the type species, but, on examining the specimens at the Gray Herbarium, we find that Dr. Gray labelled the specimens of Miss Dix's as "Mimulus leptaleus Gray var—" and another specimen of hers from "above Yosemite" is put on a sheet with *M. mephiticus* of Hutching's collection and the whole sheet labelled,

in Dr. Gray's handwriting, "M. mephiticus (Eunanus), Syn. Fl. N. Amer." The specimen of Miss Dix's is a larger plant with larger flowers and is undoubtedly *M. mephiticus*, described by Greene in 1885. In view of this, it has seemed advisable to accept Dr. Gray's collection from "Peregoy's, Clark's, etc., 1872," the next specimen cited, as the type.

92. **M. Jepsonii** Grant[1]

Glandular-pubescent plants; stems 3–8 cm. high, simple or usually more or less branched; leaves mostly basal, oblong, oblanceolate or spatulate, 9–15 mm. long, 2–3 mm. broad, obtuse, tapering to a short slender petiole, 1-nerved, entire, mostly clustered with the flowers toward the tips of the stem and branches; pedicels filiform, 1–2 mm. long; calyx cylindrical, 2–3 mm. long, becoming 4–5 mm. long when mature, teeth triangular, acute to subulate, almost one-third the length of the tube, nearly equal, the throat oblique; corolla bilabiate, reddish-purple, funnelform, 9–10 mm. long, marcescent, becoming filiform, the tube very slender and at least 1½ times as long as the calyx, throat abruptly expanding, slightly bearded below the lower lip, lobes short, truncate, unequal, the upper lip erect and longer than the lower, often with darker blotches down the throat, or with a large yellowish patch spotted with red; upper pair of stamens exserted, anthers glabrous; style exserted, the stigma-lobes about as long as the corolla, subequal, broadly peltate-funnelform; capsule oblong, obtuse, usually slightly exceeding the somewhat distended calyx; seeds faintly reticulate, apiculate at both ends, almost as broad as long.

Distribution: in the mountains of southern Oregon and California.

Specimens examined:

Oregon: Cherry Creek Flat, Klamath Co., 4200 ft. alt., June, 1919, *Rose 1198* (M).

[1] **Mimulus Jepsonii** Grant, sp. nov., herba glanduloso-pubescens; caulibus 3–8 cm. altis; foliis fere radicalibus, oblongis oblanceolatis, spatulatisve, obtusis, 1-nervatis; calyce 2–3 mm. longo, dentibus fere aequalibus; corolla rubro-purpurea, 9–10 mm. longa, lobis inaequalibus; staminibus glabris; stylo exserto.—Collected at Twin Lakes (Grassy Lake), Lassen Co., 7300 ft. alt., 10 June, 1910, *W. L. Jepson 4112* (Mo. Bot. Gard. Herb., Cornell Univ. Herb., and Univ. Calif. Herb., TYPE).

California: Sierra Co., 1874, *Lemmon* (G and M); Soda Springs, Nevada Co., 7000 ft. alt., 22 July, 1881, *Jones 2459* (G and Stanford); Twin Lakes (Grassy Lake), Lassen Co., 7300 ft. alt., 10 June, 1910, *Jepson 4112* (Calif., TYPE, M, and Cornell).

93. **M. Whitneyi** Gray, Syn. Fl. N. Am. ed. 2, 2^1: Suppl. 445. 1886; Smiley in Univ. Calif. Publ. Bot. **9**: 336. 1921.

Eunanus bicolor Gray in Proc. Am. Acad. **7**: 381. 1867; Greene in Bull. Calif. Acad. Sci. **1**: 103. 1885.

M. nanus var. *bicolor* Gray in Bot. Calif. **1**: 564. 1876; Syn. Fl. N. Am. 2^1: 275. 1878, and ed. 2, 1886.

Small glandular-puberulent plants, 2–4 cm. high, commonly freely branched from the base; leaves entire, elliptical to linear, rarely spatulate, 1–2 cm. long, 1–1.5 mm. broad, acute, tapering to a slender base; flowers numerous, pedicels 1–2 mm. long; calyx campanulate, 3–4 mm. long, teeth unequal, frequently incurved, lanceolate-subulate, about half as long as the tube, throat oblique; corolla funnelform, 1–1.2 cm. long, pubescent externally, marcescent, tube reddish or rarely yellow, slender, at least twice as long as the calyx, throat short, broad, and with few scattered hairs below the lower lip, lobes quadratish, nearly equal, yellow, usually with several broad, club-shaped blotches or lines of reddish-purple down the throat, occasionally the whole corolla reddish-purple or yellow; stamens included, the anthers small, mostly sparingly hispid, filaments of longer pair with retrorse hairs toward the base; style and stigma slightly longer than the upper pair of stamens, stigma-lobes oblong, the lower about half as long as the upper; capsule oblong, obtuse, usually as long as the calyx; seeds smooth, oval, apiculate at both ends.

Distribution: restricted mainly to the high Sierra Nevada Mts. of Fresno and Tulare Counties, California. First collected by Brewer on Lieut. Whitney's Expedition.

Specimens examined:

California: High Sierras, Fresno Co., 1863, *Brewer 2785* (G, TYPE); Markwood Meadow, Fresno Co., 5800 ft. alt., June, 1900, *Hall & Chandler 377* (Calif.); Mt. Silliman, Tulare Co., 10000 ft. alt., 22 Aug., 1905, *K. Brandegee* (G and Calif.); open woods near Old Mt. Whitney, 10000–11000 ft. alt.,

Aug., 1896, *Purpus 1988, 1989* (Calif.); gravelly soil, Kaweah Meadows, 9400 ft. alt., Aug., 1897, *Purpus 5650* (G and Calif.).

SECTION 6. MIMULASTRUM Gray

§ 6. MIMULASTRUM Gray in Bot. Gaz. 9: 141. 1884; Syn. Fl. N. Am. ed. 2, 2¹: Suppl. 446. 1886, excl. *M. pictus;* Dalla Torre & Harms, Gen. Siph. 457. 1900–1907.

Eunanus § *Mimulastrum* Greene in Bull. Calif. Acad. Sci. 1: 105. 1885, excl. *M. pictus.*

Desert annuals; calyx strongly angulate-plicate, the orifice oblique, teeth unequal; corolla salverform, tube short, included, throat exserted, gibbous, lobes nearly equal, rotate with erose margins; stamens approximate in pairs; style puberulent; capsule membranous, dehiscent along the inner suture and part way down the outer suture; placentae separating to the base. Sp. 94.

94. **M. mohavensis** Lemmon in Bot. Gaz. 9: 142. 1884; Gray, Syn. Fl. N. Am. ed. 2, 2¹: Suppl. 446. 1886. Pl. 10, fig. 13.

Eunanus mohavensis Greene in Bull. Calif. Acad. Sci. 1: 106. 1885.

Small profusely branched and leafy plants, 3–15 cm. high; stem and branches dark reddish-purple; leaves reddish-green, elliptical to obovate or oblong, 1–1.8 cm. long, 3–5 mm. broad, acute, entire, sessile, or the lower ones often short-petioled; flowers numerous, mostly alternating in the axils, pedicels slender, 2–3 mm. long; calyx acutely angled, deep reddish-purple, broadly campanulate with spreading teeth, often contracted at the very oblique throat, ciliate, nearly glabrous externally, puberulent on the inside, teeth broadly deltoid, acuminate, the upper tooth 2–4 mm. long, about twice as long and broad as the others, usually recurved; corolla reddish-purple, pubescent externally, tube very short, closely enfolding the ovary, scarious and constricted at the apex, throat cylindrical, exserted less than half its length, gibbous at the base, somewhat contracted at the orifice and with a few long hairs in a patch down the lower side, lobes nearly equal, rotately spreading, 8–12 mm. across, with white, ciliate, more or less erose margins, marked by numerous red branching veins, base deep reddish-purple;

stamens glabrous, included, the style slightly longer, puberulent but not glandular, upper part of ovary slightly puberulent; capsule narrowly lanceolate, included; seeds oval, at least twice as long as broad, apiculate at each end, tuberculate.

Distribution: in small patches on sandy slopes or dry washes along the Mohave River; apparently local in distribution.

Specimens examined:

California: Calico, Mohave Desert, May, 1884, *Lemmon* (Calif.); dry hills at Barstow, 29 May, 1914, *Parish 9243* (Cornell, M., Calif., and Stanford); hills just east of Barstow, May, 1903, *K. Brandegee* (Calif. and Pomona); Barstow, 2100 ft. alt., 22 April, 1914, *Jepson 5823* (Cornell, M, and Calif.); Kane Spring, Ord Mts., 1 May, 1906, *Hall & Chandler 6817* (Calif.).

An interesting desert annual with the calyx and capsule of *M. Bolanderi* but with a wholly different corolla, the latter unlike any other *Mimulus* except *M. pictus*.

SECTION 7. ŒNOE Gray

§ 7. ŒNOE Gray in Benth. Pl. Hartw. 329. 1849, name only; Bot. Calif. **1**: 563. 1876, as to *M. Douglasii, tricolor*, and *latifolius;* Syn. Fl. N. Am. ed. 2, **2**[1]: Suppl. 443. 1886, as to *M. tricolor, angustatus, Douglasii, atropurpureus, Kelloggii*, and *latifolius;* Wettst. in Engl. & Prantl, Nat. Pflanzenfam. **4**[3b]: 71. 1891; Dalla Torre & Harms, Gen. Siph. 457. 1900–1907.

§ *Eunanus* Benth. ex Gray in Proc. Am. Acad. **11**: 95. 1876, as to *M. tricolor, Douglasii*, and *latifolius;* Greene in Bull. Calif. Acad. Sci. **1**: 96. 1885, as to *E. Kelloggii* and § *Œnoe.*

Low erect annuals, mostly flowering from near the base; leaves entire or obscurely toothed, dark green, frequently red on the lower surface; calyx mostly narrow, plicate, usually scarious below the sinuses, gibbous at base, ribs often reddish, orifice strongly oblique, teeth herbaceous, unequal; corolla marcescent, reddish or rose-purple, tube slender, mostly twice as long as the calyx, throat usually with a few scattered hairs below the lower lip; stamens reddish-purple, inserted in the upper part of the tube, didynamous, the anthers connivent and approximate in pairs

forming a cross; style exserted, glandular-pubescent on upper part; stigma reddish-purple, variable; capsule much shorter than the calyx, firm, coriaceous, obtuse, bisulcate, strongly gibbous and oblique at the base, posterior suture usually sharply angled, indehiscent, tardily dehiscent at the apex and along the inner suture, or breaking near the base; placentae separating completely in fruit, the halves adherent to each valve. Sp. 95–104.

Key to the Species

A. Lower lip of the corolla more than one-third as long as the upper lip.
  a. Corolla-tube less than twice as long as the calyx.
    α. Corolla 1.8–2.3 cm. long; lower lip nearly half as long as the upper lip.. *95. M. latifolius*
    β. Corolla less than 1.8 cm. long; lobes subequal.
      I. Corolla 1.3–1.7 cm. long; capsule lanceolate.......... *96. M. Congdonii*
      II. Corolla 6–7 mm. long; capsule broadly oval............ *97. M. pygmaeus*
  b. Corolla-tube at least twice as long as the calyx.
    α. Corolla-lobes subequal; stigma-lips equal or nearly so; capsule broadly ovate or oblong.
      I. Calyx-tube puberulent; tube of the corolla 2–3 times longer than the throat................................ *98. M. tricolor*
      II. Calyx-tube viscid-villous; tube of the corolla 4–8 times longer than the throat.
        1. Lower lip of the corolla reddish-purple............ *99. M. angustatus*
        2. Lower lip of the corolla wholly or partly yellow.... *100. M. pulchellus*
    β. Corolla-lobes distinctly unequal; stigma-lips manifestly unequal; capsule cylindrical or lanceolate.
      I. Corolla 1.8–2.8 cm. long; upper lip 4–5 mm. long, less than twice the length of the lower lip; capsule 5–7 mm. long.... *101. M. modestus*
      II. Corolla 4–6 cm. long; upper lip 8–12 mm. long, usually more than twice the length of the lower lip; capsule 9–11 mm. long...................................... *102. M. Kelloggii*
B. Lower lip of the corolla less than one-third as long as the upper lip.
  a. Throat of the corolla long and urn-shaped, tube 2–3 times longer than the calyx................................ *103. M. Douglassii*
  b. Throat of the corolla funnelform, tube little exserted...... *104. M. Traskiae*

95. M. latifolius Gray in Proc. Am. Acad. **11**: 95. 1876; Syn. Fl. N. Am. **2**[1]: 274. 1878, ed. 2, and Suppl. 444. 1886; Curran in Proc. Calif. Acad. Sci. II. **1**: 260. 1888; Conzatti & Smith, Fl. Sin. Mex. 118. 1897.

Eunanus latifolius Greene in Bull. Calif. Acad. Sci. **1**: 99. 1885.

Simple or branched, viscid-pubescent plants; stem with some glandular hairs; leaves numerous on the upper part of the stem,

broadly ovate, 1.2–2.5 cm. long, .5–2 cm. broad, acute or obtuse, 5-nerved from the base, short-petioled or sessile; flowers mostly terminal or occasionally solitary in the axils, pedicels very short, 1–2 mm. long; calyx 1–1.3 cm. long, oblong, constricted at the very oblique throat, teeth broadly triangular, obtuse; corolla 1.8–2.3 cm. long, reddish-purple, throat short-funnelform, lower lip about half as long as the erect upper one; stigma-lips very unequal, the upper one ovate-acuminate, the lower hardly more than a scale; capsule 8–10 mm. long, oblong, obtuse, compressed laterally, arcuate, tardily dehiscent at the apex and along the inner suture to the base and less than half way along the outer suture, where it breaks away; seeds broadly ovate, apiculate at both ends, reticulate.

Distribution: in warm, rather moist places on Santa Cruz Island, off the coast of California, and Guadalupe Island, Lower California.

Specimens examined:

California: Santa Cruz Island, 1888, *T. S. Brandegee* (G, Phil., M, and Calif.).

Mexico:

Lower California: Guadalupe Island, 1875, *Edw. Palmer 58* (G, TYPE, N. Y., Phil., and M); Guadalupe Island, April, 1889, *Edw. Palmer 839* (G, U. S., and Calif.); Guadalupe Island, 1885, *Bryant* (Calif.).

M. latifolius and *M. Congdonii* resemble members of the section *Eunanus* in their short corolla-tubes. The structure of the calyx and capsule is that of typical *Œnoe* and they are regarded as transitional species between the two sections.

96. **M. Congdonii** Rob. in Proc. Am. Acad. **26**: 175. 1891.

Eunanus Congdonii Greene in Erythea **1**: 247. 1893.

Eunanus Douglasii var. *parviflorus* Greene, Manual Bay Region, 276. 1894.

Eunanus Kelloggii var. *parviflorus* (Greene) Jepson, Fl. W. Mid. Calif. 404. 1901.

Subacaulescent with numerous branches from near the base; stem and branches glandular-pubescent; leaves broad, obovate, 1.5–3.5 cm. long, .5–1.5 cm. broad, tapering to a slender ciliated

petiole; pedicels stout, 2–4 mm. long; calyx cylindrical, 9–13 mm. long, constricted slightly below the throat, the teeth unequal, short, broad, obtuse, not ciliate; corolla 1.3–1.7 cm. long, rose-pink, tube with scattered glandular-pubescent hairs on the outer surface, slender, little exserted, throat short, not funnelform nor much enlarged, lobes rounded, subequal, and little spreading; longer pair of stamens stout, exserted, very much dilated at the point of insertion, the broad part attached to the tube, shorter pair with very slender filaments and often with aborted anthers; style pale pink, upper lip of stigma ovate, obtuse, lower lip triangular, acute and very short; capsule slender, lanceolate, acute, tardily dehiscent down the inner suture; seeds oblong, apiculate at both ends, scurfy-muriculate with anchor-shaped hairs.

Distribution: foothills of the central Sierra Nevada Mts. and the Coast Range Mts. of California.

Specimens examined:

California: Zimmerman's ranch, Mariposa Co., March, 1887, *Congdon* (Gray, TYPE); Zimmerman's ranch, Mariposa Co., April, 1888, and May, 1888, *Congdon* (G); Stockton Creek, March, 1889, *Congdon* (G); Aqua Fria, Mariposa Co., *Congdon* (G); Mariposa, 25 March, 1892, *Congdon* (Stanford); Stockton Creek, Mariposa Co., 4 April, and May, 1892, *Congdon* (Stanford); Mariposa, 24 March and 7 April, 1896, *Congdon* (Stanford and Pomona); Potter Valley, Mendocino Co., March, *Purpus* (R. Mt.); Cold Creek Cañon, Kelseyville, 30 March, 1904, *Irwin 40* (Calif.).

97. **M. pygmaeus** Grant[1]

Acaulescent or with stems 4–5 mm. high; leaves basal, linear or spatulate, 3–5 mm. long, 1 mm. broad, obtuse, entire, sparsely glandular-pubescent, tapering to a sessile base; flowers solitary, terminal, pedicels stout, .5–1 mm. long; calyx 3–4 mm. long, cylindrical, sparingly glandular-pubescent, tube constricted below

[1] **Mimulus pygmaeus** Grant, sp. nov., acaulescens vel cum caulibus 4–5 mm. longis; foliis radicalibus, linearibus spathulatisve, obtusis, integerrimis, sessilibus; floribus solitariis, terminalibus, pediculis, crassis; calyce 3–4 mm. longo, dentibus latis, valde inaequalibus; corolla rosea, 6–7 mm. longa; capsula late ovata.—Collected at Egg Lake, Modoc Co., California, 8 June, 1894, by *M. S. Baker* and *Frank Nutting* (Univ. Calif. Herb. no. 26888, TYPE).

the middle and expanded by the mature capsule, teeth thick, broad, linear, obtuse, very unequal, the upper about one-half as long as the tube; corolla funnelform, 6–7 mm. long, pink, tube exserted, throat slightly expanded, lobes short, broadly truncate, unequal, slightly spreading; stamens glabrous, longer pair exserted, shorter pair with slender filaments and much smaller anthers; style exserted, stigma-lips unequal, upper lobe ovate, obtuse, the lower broad-triangular, acute, and less than half as long; capsule short, broadly oval, mucronately tipped, fully half as long as broad; seeds oblong, apiculate, scurfy-muriculate, without hairs.

Distribution: known only from the type locality.

Specimens examined:

California: Egg Lake, Modoc Co., 8 June, 1894, *Baker & Nutting* (Calif., TYPE).

98. **M. tricolor** Lindl. in Hort. Soc. Lond. Jour. **4**: 222. June, 1849; Gray in Proc. Am. Acad. **11**: 95. 1876; Bot. Calif. **1**: 563. 1876; Syn. Fl. N. Am. **2**^{1}: 274. 1878, ed. 2, and Suppl. 443. 1886; Jepson, Fl. W. Mid. Calif. 404. 1901, and ed. 2, 377. 1911. Pl. 10, figs. 12, 15.

Eunanus Coulteri Harv. & Gray ex Benth. Pl. Hartw. 329. Aug., 1849; Gray in Pac. Rail. Rept. **4**: 120. 1857.

Eunanus tricolor Greene in Bull. Calif. Acad. Sci. **1**: 99. 1885; Manual Bay Region, 275. 1894.

A short caulescent plant, freely branched from the base; branches glandular-pubescent, erect or spreading, 4–15 cm. long; leaves oblanceolate or oblong, 17–25 mm. long, 4–9 mm. broad, glandular-ciliate, tapering to a slender sessile base; pedicels 2–3 mm. long, stout; calyx campanulate, 1.2–2 cm. long, teeth short, broadly ovate, obtuse, glandular-puberulent; corolla 3–4 cm. long, tube slender, yellow, slightly puberulent, twice as long as the calyx, abruptly expanding to a broad funnelform reddish-purple throat and broad rounded spreading subequal rose-purple lobes, each usually with a large reddish-purple spot near the base, throat marked by a yellow patch dotted with red below the lower lip; anthers hairy; stigma-lips nearly equal, peltate-funnelform, ciliate; capsule short-ovate or oblong, slightly compressed laterally and sharply angled on the sutures, tardily dehiscent; seeds oval, apiculate at both ends, papillate.

Distribution: abundant in late-drying depressions; Oregon, southward through the Sacramento and San Joaquin Valleys and foothills of the Sierra Nevada Mts. of California.

Specimens examined:

Oregon: Pathologium, Corvallis, 30 May, 1915, *Scherer* (Ore.); ploughed field near Corvallis, 31 May, 1892, *Mulford* (G and M); 1 mile west of Corvallis, 8 June, 1912, *Weniger* (Ore.); in field on damp ground, 10 May, 1899, *Getty* (Ore.); golf links, Corvallis, 10 May, 1915, *Otto Elmer* (Ore.); in fields west of Corvallis, 27 May, 1902, *Raber* (Ore.).

California: between Exeter and Kaweah, Tulare Co., 26 April, 1895, *Eastwood* (G); near Suisun, May, 1886, *Greene 10* (Stanford); Live Oaks, San Joaquin Co., March, 1883, *Rattan* (G and Stanford); Live Oaks, San Joaquin Co., April, 1885, *Titus* (Stanford); Hernandez, San Benito Co., 16 May, 1903, *Lathrop* (Stanford); Lewis, Mariposa Co., 17 April, 1892, *Congdon* (Stanford); Stanislaus, 1853–54, *Bigelow* (G); Thalheim, Stanislaus Co., 6 March, 1916, *A. L. Grant 647* (M and Stanford); growing in late drying depressions in stiff clay soil, often coming into flower while still in the water, Elmira, Solano Co., 3 May, 1901, *K. Brandegee 168* (M, R. Mt., Calif., Stanford, and Pomona); Sweeney Creek, Solano Co., 22 April, 1919, *Jepson 8252* (Cornell and Calif.); small colonies on sites of vernal pools, Elmira, Solano Co., 6 May, 1903, *C. F. Baker 2923* (G, M, R. Mt., and Pomona); between Santa Rosa and Sebastopol, 8 June, 1905, *K. Brandegee* (M, R. Mt., and Pomona); near Vacaville, 2–6 May, 1891, *Jepson* (Calif.); low ground, Santa Rosa, Sonoma Co., 27 April, 1918, *Abrams 6901* (Stanford); Burns Valley, Lake Co., May, 1902, *Bowman 2* (Stanford); plains of Sacramento Valley, *Hartweg* (G, *type collection*); Sacramento, 7 April, 1918, *Hannibal* (Stanford); College City, Colusa Co., 6 April, 1915, *Johnson* (Calif.); Clear Creek, Butte Co., 175 ft. alt., 15–30 April, 1897, *H. E. Brown 183* (M, R. Mt., and Stanford); Chico, April, 1885, *Gray* (G); Chico, April, 1899, *Austin 158* (M and Calif.); Chico-Coville Road, 7 miles east of Chico, 24 April, 1914, *Heller 11314* (Cornell and Stanford); fields, Butte Co., May, 1897, *Bruce 2107* (Stanford); near Biggs, Butte Co., 15 May,

1902, *Heller & Brown 5554* (G, M, R. Mt., Stanford, and Pomona); near Madison, Yolo Co., 29 April, 1902, *Heller & Brown 5417* (M, R. Mt., Stanford, and Pomona).

Plants of this species begin to flower when only a half inch or so high, the flowers frequently exceeding the stem in length. The capsules vary decidedly, some being short-ovate while others are oblong.

99. **M. angustatus** Gray, Syn. Fl. N. Am. ed. 2, 2^1: Suppl. 443. 1886; Brandegee in Proc. Calif. Acad. Sci. II. **1**: 259. 1888; Jepson, Fl. W. Mid. Calif. 403. 1901, and ed. 2, 377. 1911.

M. Coulteri var. *angustatus* Gray in Proc. Am. Acad. **7**: 38. 1867.

M. tricolor var. *angustatus* Gray in Proc. Am. Acad. **11**: 95. 1876; Bot. Calif. **1**: 563. 1876; Syn. Fl. N. Am. 2^1: 274. 1878, and ed. 2, 1886.

Eunanus angustatus Greene in Bull. Calif. Acad. Sci. **1**: 99. 1885; Manual Bay Region, 275. 1894.

M. Clarkii Kell. ex Curran in Proc. Calif. Acad. Sci. **1**: 259. 1888.

Short caulescent plants, 4–5 cm. high; leaves numerous, basal, linear to spatulate, 1–1.5 cm. long, 1–2 mm. broad, glandular-villous to nearly glabrous; calyx 5–7 mm. long, gibbous and contracted over the capsule at maturity, tube viscid-villous, throat oblique, teeth unequal or nearly equal, slightly spreading, broad and obtuse, from one-fourth to one-half the length of the tube; corolla 3–5 cm. long, rose-purple, mostly longer than the stems, tube glandular-pubescent externally, elongated, filiform, 4–8 times the length of the short funnelform throat, lips subequal, upper slightly longer, lower with a large deep crimson spot on each lobe and a yellow patch dotted with red down the throat; anthers hairy, the filaments of the longer pair pubescent; stigma peltate-funnelform with subequal lips; capsule broadly ovate, obtuse, thinner near the base and tardily circumsessile; seeds oblong, favose-pitted.

Distribution: Coast Ranges and foothills of the Sierra Nevada Mts. north and east of San Francisco Bay, California. Commonly coming up in great abundance in drying depressions where the water had been standing in pools.

Specimens examined:

California: Placer Co., *Rattan* (G, TYPE); Long Valley, 1866, *Bolander 4690* (G, U. S., and M); dry run in field, Sherwood Valley, Mendocino Co., 10 June–13 August, 1902, *Jepson 1846* (Calif.); plentiful in open places in the chaparral near Cohasset, Butte Co., 12 April, 1915, *Heller 11806* (Cornell, M, and Stanford); Plumas Co., 1877, *Austin 146* (G); Sierra foothills, Eldorado Co., 22 May, 1903, *Gross 106* (Stanford); Auburn, 1882, *Ames* (Phil.); Amador Co., April, 1886, *T. S. Brandegee* (M, Calif., and Stanford); Amador Co., May, 1886, *Curran 6* (Stanford); Pioneer, Amador Co., 3000 ft. alt., 28 May, 1896, *Hansen 1683* (M and Stanford); Howell Mt., Napa Co., 18 May, 1902, *Tracy 1536* (R. Mt. and Stanford); borders of surface streams, Mt. George, 28 April, 1893, *Jepson* (N. Y. and Calif.); springy place on side of ridge between Pinehurst and Sequoia Lake, Fresno Co., 3 June, 1921, *Ottley 1437* (Wellesley, Cornell, and M).

100. M. pulchellus (Drew) Grant, comb. nov.

Eunanus pulchellus Drew ex Greene, Pittonia **2**: 104. 1890.

M. angustatus Hall, Yosemite Fl. 225. 1912, not Gray.

Dwarfed annuals, 3–6 cm. high, the flowers subsessile and much longer than the stems; leaves clustered thickly at the base, linear or oblanceolate, often spatulate, 1–2 cm. long, entire or obscurely toothed, villous to nearly glabrous; calyx 6–8 mm. long, open, funnelform, tube viscid-villous with an upward appressed pubescence on the inner surface, contracting over the capsule at maturity, teeth broadly triangular, acute or obtuse, spreading, one-fourth to one-half the length of the tube; corolla 2.5–5 cm. long, tricolored, tube long, slender, 4–6 times the length of the short broad dark reddish-purple throat, sparsely pubescent externally, the upper lip reddish-purple and shorter than the wholly or partly yellow lower one, the latter dotted with red; anthers hairy, filaments sparsely pubescent; stigma-lips ciliate, peltate-funnelform, subequal; capsule short, broadly ovate, not compressed, the lower part thinner, breaking away above the base; seeds oblong, favose-pitted.

Distribution: in large patches on moist meadows of the central

Sierra Nevada Mts. from Tuolumne Co. to the Yosemite Valley, California.

Specimens examined:

California: moist meadows near Lake Eleanor, Tuolumne Co., 1890, *Chestnut & Drew* (Calif., *type collection*); Lake Eleanor, 28 June, 1889, *Chestnut & Drew* (Calif.); Saint's Rest on the Mono State Highway, Tuolumne Co., 4000 ft. alt., 10 June, 1917, *A. L. Grant 954* (M); near Confidence, 3000 ft. alt., 14 May, 1916, *A. L. Grant 766* (M, Calif., and Stanford); near Confidence, 10 June, 1917, *A. L. Grant 957* (G, Phil., U. S., M, Ore., Calif., Stanford, and Pomona); Hetch-Hetchy Valley, June, 1900, *Bioletti* (Calif.); Hog Ranch road, near Hetch-Hetchy Valley, 4600 ft. alt., 9 June, 1911, *H. M. Hall 8897* (R. Mt., Calif., and Stanford); Hog Ranch above Hetch-Hetchy Valley, 4700 ft. alt., 14 June, 1917, *A. L. Grant 976* (G, N. Y., Phil., U. S., Calif., Stanford, and Pomona); near Lake Eleanor on Cherry Creek, 4500 ft. alt., 12 June, 1918, *A. L. Grant 1232* (M); Snow Creek, Mariposa Co., 27 May, 1893, *Congdon* (Stanford); Yosemite Valley, May and June, 1900, *Bioletti* (Calif.).

101. M. modestus Eastw. in Zoe **5**: 84. 1900.

M. Congdonii Jepson, Fl. W. Mid. Calif. 404. 1901, and ed. 2, 377. 1911, not Robinson.

Small erect plants, 2–5 cm. high; stem thick, glandular-pubescent, simple or branched from the base; leaves numerous, broadly obovate or spatulate, 1–2 cm. long, 5–8 mm. broad, distinctly 3-nerved, petiole broad, often nearly as long as the blade; pedicels 3–4 mm. long, later reflexed; calyx narrowly tubular, 9–11 mm. long, glandular-pubescent, scarious and slightly gibbous at the base, becoming markedly so at maturity, teeth very short, ovate, obtuse, ciliate; corolla 1.8–2.8 cm. long, rose-purple, tube elongated and slender, pubescent, 4–6 times the length of the broad funnelform dark rose-red throat, lips unequal, the upper less than twice the length of the lower, throat with two yellowish patches below the lower lip, these bordered and streaked with red, limb 8–10 mm. in diameter; stamens unequal, the shorter pair with slender filaments and frequently aborted, the

longer pair with broad filaments inflated at the base; style and stigma hardly longer than the upper pair of anthers, lips unequal, the upper one long, ovate-acute, papillate, the lower triangular-acute, almost scale-like; capsule cylindrical, obtuse, 5–7 mm. long, tardily dehiscent down the upper suture; seeds oblong, apiculate at both ends, scurfy-muriculate with anchor-shaped hairs.

Distribution: central Sierra Nevada Mts. and Coast Range Mts., from Shasta Co. to Tulare Co., California.

Specimens examined:

California: Old Bolinas Trail, Mt. Tamalpais, 17 March, 1900, *Eastwood* (Calif. and Calif. Acad., TYPE); near Alpine, on road to Bolinas, Marin Co., 7 April, 1918, *Campbell* (Calif. Acad.); near Rock Spring, Mt. Tamalpais, 12 April, 1918, *A. L. Grant 1208* (M); Lagunitas, 1892, *K. Brandegee* (Calif.); on ridge above Larkspur, Marin Co., 11 March, 1917, *Eastwood* (Calif. Acad.); Ogles, Coast Range, 17 March, 1889, *Fritchey* (M); Milo, Tulare Co., 24 April, 1918, *Goetz 2* (M); Milo, Tulare Co., May, 1918, *Goetz 3* (G, Cornell, N. Y., and M); fields near Springfield, 800–1000 ft. alt., Apr.–Sept., 1897, *Purpus 5011* (M); Deer Trace Hill, opposite Springfield on Tule River, Tulare Co., 26 March, 1897, *Dudley* (Stanford).

This species stands very close to *M. Kelloggii*, but it is smaller in all of its parts. In each one of the corollas of *M. modestus* and *M. Kelloggii* examined, the upper lip of the stigma curved downward and touched the upper pair of anthers. In one bud just ready to open, the stigma was coated with pollen and the open anther-sacs were nearly empty.

102. M. Kelloggii Curran ex Gray, Syn. Fl. N. Am. ed. 2, 2^1: Suppl. 443. 1886; Jepson, Fl. W. Mid. Calif. 404. 1901, and ed. 2, 377. 1911. Pl. 10, figs. 3, 6.

M. Douglasii Gray in Pac. Rail. Rept. **4**: 120. 1857; Proc. Am. Acad. **11**: 95. 1876; Bot. Calif. **1**: 563. 1876; Syn. Fl. N. Am. 2^1: 274. 1878, and ed. 2, 1886, as to description of corolla and fruit.

Eunanus Kelloggii Curran ex Greene in Bull. Calif. Acad. Sci. **1**: 100. 1885.

Eunanus Douglasii Greene, Manual Bay Region, 275. 1894, not Benth.

Stem .5–4 dm. high, glandular-pubescent, simple or usually branched from near the base; leaves broadly rhombic-ovate or oblong, 1.5–5 cm. long, 4–15 mm. broad, obtuse, 3–5-nerved, tapering gradually to a petiole about half as long as the blade; pedicels stout, 6–8 mm. long; calyx narrowly cylindrical, 1.2–2.5 cm. long, densely glandular-pubescent, scarious below the sinuses, slightly gibbous at base, becoming markedly so at maturity, ribs prominent and mostly reddish, teeth short, obtuse, corolla 4–5 cm. long, rose-purple, shaded with darker rose-purple in the throat beneath each lobe, tube nearly glabrous externally, slender, 4–6 times the length of the short funnelform throat, lobes broad, the upper lip erect, 8–12 mm. long, usually more than twice as long as the spreading lower one, limb 1.3–1.5 cm. in diameter, lower part of throat and tube yellow or white dotted with red and with two elongated yellow spots below the lateral lobes of the lower lip; stigma-lips unequal, ciliate, the lower rounded and less than half as long as the oblong acute upper one; capsule slender, almost cylindrical, closely invested by the calyx, 9–11 mm. long, slightly arcuate, usually reflexed when mature, very slowly dehiscent along the upper suture, sometimes rupturing the closely invested calyx; seeds oval, apiculate at both ends, scurfy-muriculate with scattered stipitate anchor-shaped hairs, nearly covered by the thin margins of the placentae.

Distribution: not uncommon in the foothills of northern and central California.

Specimens examined:

California: ridges and meadows near Marble Mountain, Siskiyou Co., 1400 ft. alt., June, 1901, *Chandler* (Stanford); Klamath River, Humboldt Co., 1400 ft. alt., June, 1901, *Chandler 1480* (G and M); Pitt River near Pitt, 28 March, 1913, *L. E. Smith 14* (Calif. Acad.); near Redding, 26 May, 1905, *Heller* (M); Reed Road near Furnaceville, Shasta Co., 2 May, 1900, *M. S. Baker* (Pomona); McCloud's Fork, Shasta Co., 24 April, 1913, *L. E. Smith 116* (Calif. Acad.); Eldorado Co., May, 1884, *Curran* (Stanford); Eldorado Co., 1866, *Rattan* (Stanford); Iron Canyon, Butte Co., May, 1896, *Austin 157* (M); above

Clear Creek on the Paradise Road, Butte Co., 8 May, 1914, *Heller 11374* (M, Calif. Acad., and Stanford); near Clear Creek, Butte Co., 175 ft. alt., 15–30 April, *H. E. Brown 198* (Phil., M, Deam, R. Mt., and Stanford); Berry Canyon, near Clear Creek, Butte Co., 6 May, 1902, *Heller & Brown 5464* (M, R. Mt., Stanford, and Pomona); Little Chico, April, 1897, *Bruce 2102* (Stanford); Chico, without date, *Bidwell* (G); DeSabla, Butte Co., June, 1917, *Edwards* (Stanford); near Bennett Spring, Glenn Co., about 3000 ft. alt., 3 June, 1915, *Heller 11934* (Cornell, M, G, Calif. Acad., and Stanford); Stiver's Ranch near Crane Creek, Tehama Co., 25 April, 1899, *Jepson 63m* (Calif.); Folsom, 1884, *Curran* (G); Sacramento Valley, 1866, *Rattan* (Stanford); near Washington, Nevada Co., 12 June, 1893, *Dudley* (Stanford); Auburn, May, 1886, *Ames 13* (Stanford); rocky gravelly hillsides, Auburn, 1866, *Bolander 4521* (G); Amador Co., May, 1886, *T. S. Brandegee* (M); Agricultural Station, Amador Co., 2000 ft. alt., April, 1893, *Hansen 109*, a depauperate form (M and Stanford); Volcano, Amador Co., 3000 ft. alt., April, 1895, *Hansen 1291* (M and Stanford); Calaveras Co., *Heerman* (Phil. and M); Yankee Hill near Columbia, Tuolumne Co., 8 June, 1915, *Jepson 6398* (Calif.); growing in sandy places along the roadsides, Italian Bar, beyond Columbia, Tuolumne Co., 2000 ft. alt., 14 May, 1915, *A. L. Grant 15* (M, Calif., and Stanford); gravelly hills, Sonora, 12 May, 1854, *Bigelow* (G); near Mark West Springs, Sonoma Co., 25 March, 1902, *Heller & Brown 5146* (M, Stanford, and Pomona); Petrified Forest, 5 June, 1915, *Eastwood 4613* (Calif. Acad.); Lakeport, Lake Co., 20 April, 1917, *Bentley* (Stanford); Mt. St. Helena, 1 May, 1918, *Eastwood 6835* (Calif. Acad.); trail to Caux's cabin, Napa River Basin, 25 April, 1893, *Jepson 28m* (Cornell, R. Mt., and Calif.); western crest of Vaca Mt., 1892, *Jepson 68m* (Calif.); Fremont's Expedition to California, 1846, *Fremont 201* (M); California, Whipple's Exp., 1853–54, *Bigelow* (Phil. and N. Y.).

103. M. Douglasii Gray in Proc. Am. Acad. **11**: 95. 1876, in part; Bot. Calif. **1**: 563. 1876, in part; Syn. Fl. N. Am. **2**^{1}: 274. 1878, ed. 2, 1886, in part, and Suppl. 443. 1886.

M. nanus β *subuniflorus* Hook. & Arn. Bot. Beechey's Voyage, 378. 1840.

Eunanus Douglasii Benth. in DC. Prodr. **10**: 374. 1846; Pl. Hartw. 329. 1849; Greene in Bull. Calif. Acad. Sci. **1**: 98. 1885; Howell, Fl. Northwest Am. 518. 1901, in part.

M. atropurpureus Kell. in Proc. Calif. Acad. Sci. **1**: 59. 1873.

Eunanus subuniflorus Greene, Manual Bay Region, 275. 1894.

M. subuniflorus Jepson, Fl. W. Mid. Calif. 404. 1901, and ed. 2, 377. 1911; Piper, Contr. U. S. Nat. Herb. **11**: 508. 1906.

Short-caulescent plants, 2–6 cm. high; stems erect, viscid or glandular-pubescent; leaves rhombic-ovate or oblong, 1.5–3 cm. long, 6–10 mm. broad, 3–5-veined, hirsute, tapering to a short broad petiole; flowers on short thick pedicels, often longer than the stem; calyx 1–1.4 cm. long, tubular, constricted at the throat, teeth triangular, obtuse, short, ciliate, tube sparingly hirsute; corolla 4–5.5 cm. long, sparsely puberulent on the outer surface, tube white or yellow, slender, 2–3 times the length of the calyx, expanding abruptly to a broad, oblong, urn-shaped throat, rose-purple above and closely streaked with darker rose-purple below, lobes rose-purple, upper lip erect, 7–8 mm. long, lower lip very short, middle lobe 2 mm. long with two yellow patches near the margin, lateral lobes obsolete or nearly so; longer pair of stamens with puberulent filaments; stigma-lips unequal, the upper lip oblong, acuminate, ciliate, the lower triangular, scale-like; capsule ovate, tardily dehiscent down the inner suture; seeds oval, apiculate, scurfy-muriculate.

Distribution: foothills of southern Oregon, southward to central California.

Specimens examined:

Oregon: Roseburg, Umpqua Valley, April, 1887, *Howell 1242* (M and Ore.); Waldo, April, 1892, *Howell 1466* (R. Mt. and Calif.); Merlin, 14 May, 1887, *Henderson 753* (Ore. and Stanford); Corvallis, 14 May, 1887, *Getty* (Ore.); Grant's Pass, 15 April, 1915, *Canby 35* (Ore.); Wimer, 9 April, 1889, *Hammond* (G).

California: Mendocino Co., 1866, *Bolander 4796* (M); gravelly soil where wet in spring, Dinsmore's ranch opposite Buck Mt., Humboldt Co., 2500 ft. alt., 19 June, 1913, *Tracy 4208* (Calif.);

near Clear Creek, Butte Co., 175 ft. alt., 1–15 April, 1897, *Brown 148* (M); Chico, 25 Dec., 1882, *Parry* (M); mesa east of Chico, Feb., 1896, *Austin 227* (M); Chico, 1879, *Bidwell* (G); Eldorado Co., April, 1884, *Curran* (Phil. and Stanford); Sweetwater, April, 1884, *Curran* (G); Auburn, 1878, *Ames* (G); Agricultural Station, Amador Co., 2000 ft. alt., April, 1891, *Hansen 108* (M and Stanford); Amador Co., April, 1889, *Brandegee* (M and Stanford); Table Mt. above Rawhide, Tuolumne Co., 2000 ft. alt., 11–16 April, 1919, *Ferris 1491* (Stanford); in heavy soil, French Flat, Tuolumne Co., 1400 ft. alt., 11–16 April, 1919, *Ferris 1550* (Stanford); Columbia, Tuolumne Co., 31 May, 1915, *Jepson 6335* (Cornell and Calif.); western side of Mariposa Valley, 12 April, 1903, *Congdon* (M); Mariposa, 24 March, 1895, *Congdon* (M); near Milo, Tulare Co., 24 April, 1919, *Goetz 4a* (M); Live Oaks, San Joaquin Co., 15 March, 1886, *Rattan* (Stanford); Live Oaks, March, 1883, *Rattan* (Stanford); near West Point Inn, Mt. Tamalpais, 12 April, 1918, *A. L. Grant 1207* (Cornell, M, and Calif.); southern slopes of Walker Cañon, near Pine Peak, Vaca Mts., 11 March, 1890, *Jepson 61m* (Calif.); Lakeport, Lake Co., 16 May, 1917, *Bentley* (Stanford); top of dry hills, Marin Co., 1860–62, *Brewer 953* (G); bare hill above Mud Lakes, San Mateo Co., 31 March, 1918, *Ferris 758* (Stanford); by cross roads, between Woodside and Crystal Springs Lake, San Mateo Co., 23 March, 1915, *Abrams 5566* (Stanford); foothills near San Mateo, 12 April, 1903, *C. F. Baker 515* (Pomona); Hernandez, San Benito Co., 18 April, 1903, *Lathrop* (Stanford); Monte Bello, Santa Clara Co., 2 April, 1904, *Abrams* (Stanford); summit of the first ridge west of Los Gatos, 25 March, 1904, *Heller 7273* (M and Stanford); open hillsides, head of Stevens Creek, Santa Clara Co., 2 April, 1904, (Stanford); Loma Prieta, Santa Clara Co., 4 April, 1894, *Davy 438* (Calif.); Mt. Hamilton, April, 1903, *Elmer 5049* (Stanford); Santa Lucia Mts., April, 1898, *Plaskett 76* (G); California, *Coulter 636* (G and Phil.); California, *Douglas* (G and N. Y., *type collection*).

The urn-shaped corolla-tube and the nearly obsolete lower lip of the corolla distinguish this species from all of the other *Mimuli*.

104. M. Traskiae Grant in Field Mus. Nat. Hist. Bot. Ser. **5:** 226. 1923.

Stem glandular-pubescent, 10–14 cm. high, simple; leaves few, broadly ovate, 3–4 cm. long, 1–2 cm. broad, entire, nearly glabrous, the lowermost tapering to a short petiole, the upper nearly sessile; pedicels slender, 3–4 mm. long; calyx narrowly oblong, 1.7–2 cm. long, glandular-pubescent, tube membranous, throat spreading, teeth long-ovate, the upper incurved and at least twice the length of the others; corolla 2–2.7 cm. long, reddish-purple and white, tube slender, slightly longer than the uppermost calyx-tooth and 6–8 times as long as the short funnelform throat, lips unequal, the lower reddish-purple with very short rounded lobes, the upper white with broad erect lobes; style slightly exserted, it and the upper pair of stamens villous, stigma-lips unequal, the upper ovate, acute, the lower triangular and less than half as long; capsule 8 mm. long, tardily dehiscent; seeds not seen.

Distribution: known only from the type locality.

Specimens examined:

California: in shade, Avalon, Santa Catalina Island, March, 1901, *B. Trask* (M, no. 99805, TYPE, N. Y., U. S., and Greene).

SECTION 8. PSEUDOENOE Grant

§ 8. PSEUDOENOE Grant, new section

§ *Mimulastrum* Gray, Syn. Fl. N. Am. **2**[1]: Suppl. 446. 1886, as to *M. pictus*.

Eunanus § *Mimulastrum* Greene in Bull. Calif. Acad. Sci. **1:** 105. 1885, as to *M. pictus*.

Desert annuals; calyx cylindrical, teeth broad, short, unequal; corolla salverform, tube very short, throat included, cylindrical, gibbous at the base and somewhat contracted at the apex, limb rotately spreading, the lobes reticulately veined with red, unequal; stamens and style included, style glandular-pubescent; stigma-lips unequal, the lower one nearly obsolete; capsule coriaceous or woody, narrowly cylindrical, mucronate, gibbous at the base, readily dehiscent part way along the inner suture and for a short distance along the outer, usually rupturing the closely

invested calyx; placentae separating to the base and adherent to each valve. Sp. 105.

105. M. pictus (Curran) Gray, Syn. Fl. N. Am. ed. 2, 2[1]: Suppl. 446. 1886.

Eunanus pictus Curran, in herb., ex Greene in Bull. Calif. Acad. Sci. **1**: 106. 1885.

Stem more or less 4-angled, simple or branched from the base, 10–25 cm. high, viscid-pubescent with some glandular hairs; leaves thin, few, obovate to oblong, 1.3–2.3 cm. long, 3–9 mm. broad, obtuse, sessile, entire or often irregularly toothed; flowers few, pedicels stout, 2–3 mm. long; calyx cylindrical, accrescent, 1–1.5 cm. long, 4–5 mm. wide, not constricted at the throat, membranous, reticulately veined, more or less viscid-villous with some glandular hairs, weakly angled, teeth short, broadly triangular, obtuse, the upper not much longer than the others; corolla 10–12 mm. long, scarcely exceeding the calyx, deep reddish-purple, tube 2–3 mm. long, constricted at the top, throat cylindrical, gibbous at the base and with a patch of long hairs on the lower side, orifice slightly constricted, limb rotately spreading, lobes deep reddish-purple at the base, unequal, the lower one larger and hairy, margins white, reticulately veined with red; stamens glabrous, often not approximate in pairs; stigma-lobes unequal, upper oblong, lower almost obsolete; capsule slightly shorter than the calyx; seeds oblong, about twice as long as broad, apiculate at both ends, reticulate.

Distribution: known only from Central California. Mrs. K. Brandegee says that it has the strong tobacco-like odor common in some of the species of the section *Eunanus*.

Specimens examined:

California: Keene Station, June, 1884, *Curran* (Calif., TYPE, and Stanford); Tehachapi, June, 1884, *Curran* (G, Calif., and Stanford); Lindsay, 19 April, 1921, *Ferris* (Calif. Acad.); Porterville, 12 April, 1922, *J. Kelley* (Calif. Acad.).

SECTION 9. TROPANTHUS Grant

§ 9. TROPANTHUS Grant, new section

Glabrous shrubs; leaves pinnately veined, coriaceous, shining, covered with sessile glands; calyx cylindrical, coriaceous, gland-

ular, spirally twisted over the capsule in fruit, teeth equal; corolla bilabiate, tube elongated, ampliate, lobes unequal; anthers glabrous; style pubescent; capsule coriaceous, tardily dehiscent to the base along both sutures, placentae separating completely. Sp. 106.

106. M. Treleasei Grant[1] Pl. 3, fig. 1.

Stem woody, terete, mahogany-colored, glabrous; leaves obovate or elliptical, 2–3 cm. long, 1–1.5 cm. broad, acute, denticulate along upper half, with mucronate teeth, thick, almost coriaceous, glabrous, shining, covered with sessile glands, tapering to a short, narrow petiole, smaller leaves fascicled in the axils; pedicels stout, shorter than the leaves; calyx cylindrical, 1.4–1.5 cm. long, leathery, covered with sessile glands, becoming spirally twisted over the capsule in fruit, teeth ciliate, truncate, tipped with a slender almost subulate point; corolla tubular, 4.2–4.4 cm. long, throat ampliate, tube at least twice as long as the calyx, pubescent externally, lobes short, rounded, slightly erose, ciliate, 8–10 mm. long, lobes of the upper lip longer and broader than those of the lower lip and strongly reflexed, lower lip more or less spreading; stamens exserted, filaments thin, flattened, pubescent, anthers glabrous; style sparingly pubescent, stigma lobes oblong, equal; capsule included, about half as long as the calyx, slightly stipitate, thick, coriaceous, broadly oblong, 7 mm. long, 4 mm. wide, compressed, tardily dehiscent to the base along both sutures; placentae separating completely; seeds oblong, longitudinally wrinkled.

Distribution: known only from the type locality.

Specimens examined:

Puebla: Tehuacan, 2 June, 1905, *Trelease 68* (M, TYPE).

M. Treleasei is a peculiar species, combining the calyx characters of *Eumimulus* with the shrubbiness, the pubescent style,

[1] **Mimulus Treleasei** Grant, sp. nov., caules lignosi, glabri; foliis obovatis ellipticisve, acutis, denticulatis, dentibus mucronatis, petiolis brevibus, crassis, coriaceis lucidis, cum glandibus sessilibus; pediculis crassis, foliis brevioribus; calyce 1.4–1.5 cm. longo, coriaceo, intorto super capsulam in fructu, dentibus ciliatis, truncatis, mucronatis; corolla tubulata, 4.2–4.4 cm. longa, tubo calyce duplo longiore, lobis brevibus, rotundis, ciliatis; staminibus exsertis, antheris glabris; stylo vix pubescente; capsula coriacea, tarde dehiscente.—Collected at Tehuacan, Mexico, 2 June, 1905, *Wm. Trelease 68* (Mo. Bot. Gard. Herb. 112585, TYPE).

and the separated placentae of *Diplacus*. The capsule is short and broad and apparently does not split the calyx when mature. The spiral twisting of the upper part of the calyx over the mature capsule is unlike that of any other species in the genus. The type sheet contains only two short branches of this unusual plant, and as this is the only material known it has been impossible to tell anything about the size of the plant nor can the color of the flowers be determined.

Section 10. Diplacus Gray

§ 10. Diplacus Gray in Proc. Am. Acad. **11**: 97. 1876; Syn. Fl. N. Am. **2**^{1}: 275. 1878, ed. 2, and Suppl. 442. 1886; Bot. Calif. **1**: 565. 1876; Benth. & Hook. Gen. Pl. **2**:. 947. 1876; Wetts. in Engl. & Prantl, Nat. Pflanzenfam. **4**^{3b}: 71. 1891.

Diplacus Nutt. in Taylor's Ann. Nat. Hist. I. **1**: 137. 1838; Nutt. ex Hooker in Curtis, Bot. Mag. II. **12**: under *pl. 3655.* 1838; Benth. in DC. Prodr. **10**: 368. 1846, excl. *D. rugosus;* Greene in Bull. Calif. Acad. Sci. **1**: 94. 1885; Pittonia **2**: 151. 1890; Manual Bay Region, 274. 1894; Jepson, Fl. W. Mid. Calif. 402. 1901, and ed. 2, 375. 1911; Howell, Fl. Northwest Am. 517. 1901; Abrams, Fl. Los Angeles, 363. 1904, and ed. 2, 334. 1917.

Shrubs 6–18 dm. high; leaves thick, firm, usually dark green, mostly revolute in the bud and with compound sessile glands on one or both surfaces; calyx narrow-prismatic or tubular, generally closely adhering to the capsule and ruptured by it in dehiscence, throat oblique, teeth short, unequal; corolla funnelform, yellow, orange, red, or salmon color, mostly distinctly bilabiate with wide open throat and more or less spreading irregular lobes; stamens glabrous, approximate in pairs, unequally inserted, the longer pair inflated at the point of attachment, anthers connivent at apex, glabrous; style glandular-pubescent along the upper half, often thickened at the base when mature; stigma-lips equal or subequal; capsule linear-oblong, firm, coriaceous, commonly dehiscent down the inner suture and held open along the outer one, occasionally dehiscent down both sutures, the broad placentae borne on the valves. Sp. 107–114.

Key to the Species

A. Plants glandular-villous, not glutinous; corolla-lobes nearly equal, margins entire....................................107. *M. Clevelandii*

B. Plants glutinous, with sessile compound glands; corolla bilabiate, lobes unequal, margins erose, irregularly notched or lobed.

a. Upper part of stem and calyx more or less white-woolly or villous ....108. *M. longiflorus*

b. Upper part of stem and calyx glabrous or pubescent.

α. Leaves glabrous on both surfaces.

I. Corolla 4.5–6.5 cm. long, yellow.

1. Calyx 2–3 cm. long; stems straw color or gray......109. *M. leptanthus*

2. Calyx 3–3.5 cm. long; stems yellow..................110. *M. aridus*

II. Corolla 2.5–4 cm. long, red....................114. *M. parviflorus*

β. Leaves more or less pubescent on the lower surface.

I. Leaves densely orange-pubescent beneath; corolla puberulent. ....111. *M. stellatus*

II. Leaves pale yellowish or brownish-pubescent beneath; corolla mostly glabrous.

1. Corolla yellow; leaves mostly densely pubescent beneath ....112. *M. aurantiacus*

2. Corolla red; leaves mostly sparsely pubescent below....113. *M. puniceus*

107. M. Clevelandii Brandg. in Garden and Forest 8: 134, *fig. 20.* 1895.

Diplacus Clevelandii Greene in Erythea 4: 22. 1896.

Suffrutescent, freely branched at the base, 3–6 dm. high; stems villous-pubescent with numerous glandular hairs but not glutinous; leaves oblong or lanceolate, 2.5–10.5 cm. long, 1–2.5 cm. broad, acute, tapering to a broad sessile base, entire or usually serrate along upper half, hispid, margins sometimes revolute; pedicels slender, 2 mm. long, flowers few, confined to the upper part of the stem and branches; calyx campanulate, 2.5–2.7 cm. long, glandular-pubescent externally, pubescent on the inner surface, tube narrow and constricted above the ovary, upper half spreading to an ampliate oblique throat, teeth unequal, lanceolate, obtuse, about one-third the length of the calyx; corolla 3.6–4 cm. long, golden-yellow, tube pubescent, included, expanding gradually to a broad funnelform throat, lobes rounded, entire, little spreading, nearly equal; stamens included, filaments puberulent at the base, attached to the lower part of the tube; style included, densely puberulent, slightly swollen at the base; stigma peltate-funnelform with rounded nearly equal lips;

capsule 1 cm. long, ovate-oblong, tapering slightly to the tip; seeds elliptical, apiculate at each end, muriculate.

Distribution: collected only in southern California.

Specimens examined:

California: frequent along trail on high ridge, Glen Ivy to Santiago Peak, Riverside Co., 4000 ft. alt., 14 June, 1923, *Munz 7062* (Pomona); south side of Cuyamaca Peak, San Diego Co., 6000 ft. alt., 7 July, 1894, *T. S. Brandegee* (G, U. S., Calif., TYPE, Stanford, and Pomona); Cuyamaca Mts., June, 1895, *T. S. Brandegee* (N. Y.); High Mt., near Descanso, San Diego Co., 24 May, 1906, *T. S. Brandegee* (F); Descanso Grade, San Diego Co., June, 1906, *K. Brandegee* (Pomona).

An unusual species combining characters of the sections *Diplacus* and *Eunanus*. T. S. Brandegee says that it grows in patches, spreading by underground roots.

108. M. longiflorus (Nutt.) Grant in Gentes Herb. **1**: 136. 1923. Pl. 10, fig. 2.

Diplacus longiflorus Nutt. in Taylor's Ann. Nat. Hist. I. **1**: 139. 1838, by error published as *D. longiflora;* Nutt. ex Hooker in Curtis, Bot. Mag. II. **12**: under *pl. 3655*. 1838; Benth. in DC. Prodr. **10**: 368. 1846; Greene, Pittonia **2**: 156. 1890, not Bull. Calif. Acad. Sci. **1**: 96. 1885; Davy in Gard. Chron. III. **16**: 20. 1894; Abrams, Fl. Los Angeles, 364. 1904, and ed. 2, 334. 1917.

M. glutinosus var. *brachypus* Gray in Proc. Am. Acad. **11**: 97. 1876; Bot. Calif. **1**: 566. 1876; Syn. Fl. N. Am. **2**^{1}: 276. 1878, ed. 2, and Suppl. 442. 1886.

Diplacus arachnoideus Greene in Bull. Calif. Acad. Sci. **1**: 210. 1885.

Diplacus speciosus Davy in Erythea **2**: 101. 1894; Davy in Gard. Chron. III. **16**: 20. 1894.

A profusely branched shrub, 3–9 dm. high; stem and branches densely pubescent with short scattered glandular hairs; leaves lanceolate to linear-lanceolate or oblong, 3–8 cm. long, .5–1.5 cm. broad, obtuse, entire or occasionally toothed along the upper half, tapering to a sessile base, yellowish-green, nearly glabrous above, usually pubescent beneath with branched or unbranched

hairs, the pubescence more or less deciduous, smaller leaves frequently fascicled in the axils, lower leaves sometimes petiolate; pedicels 3–10 mm. long, and, as well as the younger parts of the stem, branches, and calyces, usually densely villous and glandular-pubescent; calyx 2.5–3.5 cm. long, slender below, constricted near the middle and then expanding abruptly to a long wide throat, teeth narrow, obtuse, ciliate, the longest 7–10 mm. long; corolla 4.5–7 cm. long, cream-color to salmon-yellow, tube usually narrow and distinctly exserted, throat broad, gibbous at the base, funnelform, lobes .8–1.5 cm. long, broadly rounded or truncate, irregularly cut, erose or wavy, upper lip nearly erect, lower spreading and somewhat longer; stamens included, attached near the top of the tube; style slightly exserted, slender and usually enlarged at the base when mature; stigma-lips subequal, broadly ovate, ciliate, densely pubescent on the inner surface; capsule linear-oblong; seeds oblong, apiculate at both ends, muriculate.

Distribution: common in the foothills throughout the coast region of southern California and southward into Lower California.

Specimens examined:

California: dry rocky places, Palo Santo, San Luis Obispo Co., *Brewer 586* (G); Blochman's Ranch, Santa Maria, 17 June, 1906, *Eastwood 461* (Calif. Acad.); Sisquoc River, Santa Barbara Co., July, 1895, *M. S. Baker* (Stanford); near lake, Zaca Lake Forest Reserve, Santa Barbara Co., 19 June, 1906, *Eastwood 543* (Calif. Acad.); state highway between Santa Inez Mission and Gaviota Pass, Santa Barbara Co., 10 June, 1917, *Abrams 6529* (Stanford); Gaviota Pass, Santa Barbara Co., 19 July, 1913, *Abrams 5033* (M, Stanford, and Pomona); La Cumbre Trail, Santa Inez Mts., 28 Aug., 1909, *Abrams 4321* (Stanford); Santa Cruz Island, 16–17 July, 1917, *Eastwood 6388* (Calif. Acad.); Santa Cruz Island, 6 June, 1918, *Miller* (Calif. Acad.); San Ysidro ranch, Aug., 1913, *Newell* (Calif. Acad.); Santa Barbara, 25 April, 1913, *G. B. Grant* (Stanford); Santa Barbara hills, 400 ft. alt., 14 May, 1907, *H. M. Hall 7739* (M); Mission Cañon, Santa Barbara, 21 April, 1908, *Eastwood 19* (M); Santa Barbara, 13 July, 1880, *Earle* (M); Santa Barbara, May, 1902, *Elmer 3959* (M and Stanford);

Santa Barbara, May, 1889, *K. Brandegee* (M); at junction of Rattlesnake Cañon Road, Santa Barbara, 23 May, 1911, *Nichols 905* (Stanford); Eucalyptus Drive, Santa Barbara, 23 May, 1911, *Nichols 907* (Stanford); Sycamore Cañon, Santa Barbara, 23 May, 1911, *Nichols 908* (Stanford); Santa Barbara, 1885, *Gray* (G); Casitas Pass, Ventura Co., 500 ft. alt., 6–8 May, 1902, *H. M. Hall 3160* (Stanford and Pomona); La Casitas, 24 July, 1911, *Nichols 1013, 1014, 1016, 1017* (Stanford); dry rocks, Ojai Valley, 8 April, 1888, *Batchelder* (G); Nordhoff, Ventura Co., 12 April, 1916, *Eastwood 4960* (Calif. Acad.); Saticoy, 17 April, 1916, *Eastwood 5051* (Calif. Acad.); Conejo Grade, Ventura Co., 10 July, 1923, *Wilkinson 1* (Cornell); Sulphur Mt. Spring, Ventura Co., 1000–2000 ft. alt., 12 June, 1908, *Abrams & McGregor 55* (Stanford and Pomona); Mt. Lowe, 19 July, 1915, *Drushel* (Drushel); Mt. Wilson, 19 July, 1915, *Drushel* (M and Drushel); Wilson's Peak, 1 Aug., 1890, *I. M. Johnston* (Pomona); mts. near Claremont, 15 May, 1909, *C. F. Baker 5320* (Stanford and Pomona); Topango Cañon, Santa Monica Mts., 3 June, 1916, *Hiatt* (M and Pomona); Santa Monica Forestry Station, summer of 1897, *Barber 298* (M); Santa Monica Mts., 1000 ft. alt., 15 May, 1920, *Munz & Harwood 4010* (M and Pomona); Sepulveda Cañon, Santa Monica Mts., 15 June, 1902, *Abrams 2543* (M and Stanford); La Crescenta, *Wislizenus 1291*, in part (M); cañons, Los Angeles, June, 1888, *Hasse* (M); stony hillsides, Lone Hill, Glendora, 11 April, 1918, *Munz 2033* (Pomona); Altadena, 24 May, 1904, *G. B. Grant 286* (M); Russell's Lake, Los Angeles Co., 18 July, 1913, *Abrams 5020* (Stanford and Pomona); Lone Hill near San Dimas, Los Angeles Co., 19 April, 1919, *Parish 19264* (M); dry ground under pines, North Fork San Antonio Cañon, 7500 ft. alt., 28 July, 1917, *I. M. Johnston 1607* (Stanford and Pomona); on a rock slide, San Antonio Mts., 5500 ft. alt., 16 June, 1918, *Parish 11987* (M); Cañon Diablo, San Bernardino Mts., 2000 ft. alt., 8 June, 1917, *Parish 11346* (M and Pomona); Johnson's Pastures, 15 May, 1916, *Robinson* (Pomona); Arrowhead Springs, San Bernardino Mts., 13 May, 1891, *Fritchey 6* (M); Arrowhead Hot Springs, 21–28 May, 1906, *G. B. Grant* (Stanford); vicinity

of San Bernardino, 1000–2500 ft. alt., 26 June, 1897, *Parish 4468* (G, M, and Calif.); foothills, San Bernardino Co., May, 1888, *Parish* (M); vicinity of San Bernardino, 1000–2500 ft. alt., 18 May, 1901, *Parish 4792* (Stanford); southern California, 1876, *Parry & Lemmon 311* (M).

Mexico:

Lower California: Santa Tomas hills, northern Lower California, 17 May, 1886, *Orcutt* (M); near San Rafael, northern Lower California, 11 July, 1885, *Orcutt 1295* (G and M); All Saints Bay, 16 May, 1885, *Greene* (G and Stanford).

108a. Var. **calycinus** (Eastw.) Grant, comb. nov.

Diplacus calycinus Eastw. in Bot. Gaz. **41**: 287. 1908.

Stems numerous, irregularly branched, light brown or straw-colored, upper part densely woolly; leaves obovate or oblong, obtuse, 2–6 cm. long, 3–23 mm. wide; pedicels and calyces densely viscid-woolly with long white, mostly unbranched hairs, tube constricted near the center, often breaking at or near the constriction; capsule about half as long as the calyx.

Distribution: southern part of the Sierra Nevada Mts., California.

Specimens examined:

California: rocks near Springfield, 1000–2000 ft. alt., April–Sept., 1897, *Purpus 5621* (G and M); rocks, Granite Basin, Kern River Region, 16 July, 1895, *Dudley 750* (Stanford); South Fork of Kaweah River, Tulare Co., 6000 ft. alt., 22 July, 1904, *Culbertson 4407*, distributed by *C. F. Baker* (G, M, Calif. Acad., TYPE, and Pomona); Kern River Road between Bakersfield and Bodfish, Digger Pine Belt, 29 July, 1915, *Abrams 5350* (Stanford); cañon sides from Lemon Cove to Three Rivers, about 1000 ft. alt., *Jepson 593* (Calif.); Tehipite Valley, Fresno Co., 4000 ft. alt., 6–10 July, 1900, *Hall & Chandler 511* (N. Y. and M); South Fork Kaweah, Clough Cave Ford, 19 June, 1902, *Dudley* (Stanford); Rowen, Tehachapi Mts., 14 April, 1916, *Jepson 6741* (Calif.); Tehachapi, May, 1889, *K. Brandegee* (G, M, and Stanford); Erskin Creek, 2000–3000 ft. alt., 1897, *Purpus 5338* (M); Kern Canyon, Kern Co., 26 April, 1905, *Heller 7771* (G, Phil., M,

and Stanford); Simpson Meadow, Middle Fork King's River, July, 1913, *Eliot* (Calif.); Middle Tule River, 2500 ft. alt., 26 June, 1912, *Jepson 4862* (Cornell and Calif.).

Much confusion has been caused by the large number of intermediates between *M. longiflorus* and *M. puniceus*. That the plants hybridize has been demonstrated by experimental work already discussed. These intermediates can easily be separated into four groups, of which the following two agree closely with known hybrids.

108b. M. longiflorus × M. puniceus

Stems densely glandular-pubescent; leaves oblong or lanceolate, obtuse, pubescent below; calyx 2–2.5 cm. long, puberulent, often viscid-villous at the base, the upper part not widely inflated; corolla 3.5–5 cm. long, dark red, lobes .5–1 cm. long, truncate, crenate.

Distribution: southern California from Los Angeles Co. to San Diego Co.

Specimens examined:

California: Butte, west of Lakeview, 8 May, 1920, *I. M. Johnston 2286, 2288, 2295* (M and Pomona); Puddington Cañon, 5 April, 1919, *Munz, Street & Williams 2447* (Pomona); near Murietta, Santa Ana Mts., 1500 ft. alt., 29 March, 1920, *Robinson & Crocker* (Pomona); vicinity of Riverside, 21 April, 1902, *H. M. Hall 2928* (M and Pomona); rocky hill near Moreno, Riverside Co., 17 Jan., 1920, *Barrus & Reed 115* (Cornell); mountain side at Rainbow, San Diego Co., 21 March, 1920, *Barrus & Whetzel 209a* (Cornell); Botanical Garden, University of California, 1 June, 1918, *A. L. Grant 1618* (Cornell and M).

The corolla of this hybrid is similar to that of *M. puniceus*, except that it is longer and has a broader limb. The upper half of the calyx is inflated, resembling that of *M. longiflorus*.

108c. M. longiflorus × M. puniceus.

Calyx glandular-pubescent, more or less viscid-villous on the lower part, not expanded above the middle; corolla 4–5.5 cm. long, salmon color, limb 2.5–3 cm. wide.

Distribution: southern California from Los Angeles Co. to San Diego Co.

Specimens examined:

California: San Jose Hills, 3 miles west of Pomona, 1000 ft. alt., 13 March, 1920, *Munz & Harwood 3356, 3339* (M and Pomona); Butte, due west of Lakeview, 2000 ft. alt., 8 May, 1920, *I. M. Johnston 2280, 2281, 2283, 2284, 2289, 2292, 2293, 2297* (M and Pomona); hills near Ysidora, San Diego Co., 22 April, 1903, *Abrams 3286* (G and M); San Diego, 1874, *Cleveland* (M); Pala Mission, San Diego Co., 12 April, 1920, *Jepson 8493* (Calif.); Botanical Garden, University of California, 1 June, 1918, *A. L. Grant 1619* (G, Cornell, M, and Pomona).

The flowers of this hybrid seem to be intermediate between the two parents. The calyx is of the general shape of that of *M. puniceus* whereas the corolla is similar to that of *M. longiflorus*, except in regard to color. The amount of hairiness varies, but in general it is intermediate between the two parents.

It is probable that the plants of the two other groups are also of hybrid origin, but further experimental work will have to be done to determine their exact status. Until such studies are made, it seems advisable to give the members of these two groups varietal names.

108d. Var. rutilus Grant[1]

Stem, branches, calyces, and the short pedicels densely glandular-villous; leaves numerous, narrowly oblong to broadly lanceolate, obtuse, dentate, dark green, villous at the base, pubescent on the lower surface; corolla 4.5–5.5 cm. long, dark velvety-red, varying to salmon-red, tube as long as the calyx, throat ventricose, lobes .8–1.5 cm. long, broad, truncate, irregularly cut; stamens short, included in the lower part of the throat; style included; stigma-lips subequal, the longer ovate-obtuse, the

[1] **Mimulus longiflorus var. rutilus** Grant, var. nov., caulis, rami, calyces et breves pediculis dense glanduloso-villosi; corolla rutila; staminibus brevibus, inclusis; stylo incluso.—Collected at Santa Susanna Pass, Ventura Co., 10 June, 1920, *Adele Lewis Grant 1650* (Gray Herb., U. S. Nat. Herb., Phil. Acad. Nat. Sci. Herb., N. Y. Bot. Gard. Herb., Cornell Univ. Herb., Mo. Bot. Gard. Herb., no. 894182, TYPE, Rocky Mt. Herb., Calif. Acad. Sci. Herb., Univ. Calif. Herb., Stanford Univ. Herb., and Pomona Coll. Herb.).

shorter deltoid; capsule almost as long as the calyx and with no tubercular enlargement at the apex.

Distribution: foothills in Ventura Co. and Los Angeles Co., California.

Specimens examined:

California: Santa Susanna Pass, Ventura Co., 10 June, 1920, *A. L. Grant 1650* (G, U. S., Phil., N. Y., Cornell, M, TYPE, R. Mt., Calif. Acad., Calif., Stanford, and Pomona); Santa Susanna Mts., Feb., 1861, *Brewer 208* (G and U. S.); hills near Chatsworth Park, 3 April, 1917, *F. Grinnell, Jr.* (Pomona); Lone Hill near San Dimas Cañon, 1100 ft. alt., 17 March, 1920, *Munz 3362* (M and Pomona); Lone Hill near San Dimas, Los Angeles Co., 19 April, 1919, *Parish 19266* (M); Griffith Park, 11 June, 1902, *Braunton 472* (U. S.); San Antonio Cañon, Claremont, 23 May, 1909, *C. F. Baker 5354* (Pomona).

108e. Var. **linearis** (Benth.) Grant, comb. nov.

M. linearis Benth. Scroph. Ind. 27. 1835; Walp. Rep. **3**: 274. 1844–45.

Diplacus linearis Greene, Pittonia **2**: 156. 1890.

M. glutinosus var. *linearis* Gray in Proc. Am. Acad. **11**: 97. 1876; Syn. Fl. N. Am. **2**^{1}: 275. 1878, ed. 2, and Suppl. 442. 1886.

Diplacus leptanthus Benth. in DC. Prodr. **10**: 368. 1846, not Nuttall.

Calyx 2.5–2.8 cm. long, glandular-puberulent, not widened much in the upper part, more or less glandular-villous below, especially when in bud; corolla 4–5.5 cm. long with a wide limb, similar to that of *M. longiflorus*.

Distribution: southern California from Ventura Co. to San Diego Co.

Specimens examined:

California: canyon near Murietta, Santa Ana Mts., 29 March, 1916, *Robinson & Crocker* (M); Butte, due west of Lakeview, 2000 ft. alt., 8 May, 1920, *I. M. Johnston 2282, 2285, 2290, 2291, 2294, 2296* (M); Whittier, 18 March, 1920, *C. O. Smith 208* (Cornell); San Diego Co., May, 1889, *K. Brandegee* (M); Laguna, between Campbell's and Cameron's ranches, 21

June, 1894, *Mearns 3659* (G); near Alpine, San Diego Co., 10 July, 1912, *Abrams 4900* (G); hills near Ysidora, San Diego Co., 23 April, 1903, *Abrams 3287* (M); hills between Campo and Potrero, San Diego Co., 3 June, 1903, *Abrams 3716* (M); San Pasqual Grade, San Diego Co., 12 April, 1920, *Jepson 8504* (Calif.); California, without date, *Douglas* (G and N. Y., probably part of the type).

109. M. leptanthus (Nutt.) Grant in Gentes Herb. **1**: 136. 1923.

Diplacus leptanthus Nutt. in Taylor's Ann. Nat. Hist. I. **1**: 138. 1838, by error published as *D. leptantha;* Nutt. ex Hooker in Curtis, Bot. Mag. II. **12**: under *pl. 3655.* 1838.

Diplacus grandiflorus Grönl. in Paris Rev. Hort. IV. **6**: 402, *fig. 136.* 1857; Planchon in Fl. des Serres **9**: *pl. 883.* 1853–54; Greene, Pittonia **2**: 156. 1890.

Diplacus glutinosus var. *grandiflorus* Lindl. in Paxt. Fl. Gard. **3**: *pl. 92.* 1851–53.

Diplacus longiflorus Greene in Bull. Calif. Acad. Sci. **1**: 96. 1885, mainly, not Nuttall.

Stem and branches slender, puberulent; leaves numerous, oblong to spatulate, 2.5–5 cm. long, .7–1.4 cm. broad, rounded at apex or merely obtuse, tapering to a slender, sessile base, glabrous, shining as though varnished but not glandular, entire or slightly toothed, frequently revolute, smaller leaves often fascicled in the axils, lower leaves occasionally petioled; pedicels slender, puberulent, .6–1.5 cm. long; calyx tubular, 2–3 cm. long, slender, nearly glabrous, teeth triangular, acute, about one-fourth as long as the calyx, ciliate; corolla 4.5–6.5 cm. long, yellow, tube very slender, exserted, expanding abruptly to a long wide throat, lobes deeply cut, broad, emarginate, often with a spread of 3 cm.; stamens included; style slender, somewhat exserted, sometimes with a slight enlargement at the base; stigma-lips equal, ovate, rounded; capsule short; seeds oblong, apiculate at both ends, papillate.

Distribution: foothills of the Sierra Nevada and Coast Range Mts., California.

Specimens examined:

California: Belden, Plumas Co., 18 June, 1910, *Jepson 4150* (Calif.); American River Mills, Plumas Co., May, 1874, *Ames* (G); Emigrant Gap, July, 1916, *Herbrand* (Cornell and Calif.); Emigrant Gap, 28 June, 1882, *Jones 3288* (M, Pomona, and Calif. Acad.); De Sabla, 6 June, 1917, *Edwards* (Stanford); American River, May, 1912, *von Geldern* (Calif. Acad.); Bear Valley above Towles, July, 1894, *Brier* (Calif.); rocks by South Yuba River, Nevada Co., 14 June, 1893, *Dudley* (Stanford); Nevada City, May, 1902, *Kitts* (G and U. S.); between Chico and Forest Ranch, 18 May, 1914, *Heller 11407* (G, Cornell, M, Stanford, and Calif.); Butte Co., June, 1897, *Austin* (G); hills east of Chico, May, 1896, *Austin* (M); Sierra's, without date, *Bolander & Kellogg* (Stanford); Upper Sacramento, *Stillman* (G); Placer Co., 1893, *Hardy* (U. S.); Tassajara Hot Springs, Monterey Co., June, 1901, *Elmer 3367* (M and Stanford); Tassajara Springs, Santa Lucia Mts., June, 1901, *Dudley* (Stanford); Big Sur River, Monterey Co., July, 1897, *Bolton* (Pomona); Fremont's Expedition to California, 1846, *Fremont 510* (G and M); Saw Mill to Nacimiento River, 14–20 June, 1901, *Jepson 1691* (Calif.); Nacimiento River, Santa Lucia Mts., Monterey Co., 1–12 May, 1897, *Eastwood* (G); Nacimiento Creek, Monterey Co., 3 April, 1901, *Dudley* (Stanford); Carmel Camp near Carmel River, Monterey Co., 25 June, 1905, *Dudley* (Stanford); San Antonio Creek above the Mission, Santa Lucia Mts., 13 May, 1895, *Dudley* (Stanford); States Hot Springs, Monterey Co., July, 1918, *Reynolds* (Calif. Acad.); near Bentley's Orchard, Santa Lucia Mts., 3000 ft. alt., Aug., 1914, *MacDougal* (Stanford); Santa Lucia Mts., April, 1898, *Plaskett 122* (G and Greene).

110. M. aridus (Abrams) Grant, comb. nov.

Diplacus aridus Abrams in Bull. Torr. Bot. Club **32**: 540. 1905.

A low glabrous glutinous shrub, 2–4 dm. high; leaves oblanceolate, obovate or oblong, 2–4 cm. long, 4–10 mm. broad, entire or irregularly dentate, numerous, crowded together on the short yellow stem and branches, short-petioled or sessile, pale yellow-green, smaller leaves usually revolute; flowers numerous; pedicels stout, 5–6 mm. long; calyx 3–3.5 cm. long, funnelform with a

narrow tube and a wide spreading throat, teeth short, broadly triangular, subulate, unequal, the longest tooth 7–8 mm. long; corolla 4.5–5.5 cm. long, pale buff to yellow, tube glabrous, little exserted, expanding abruptly to an open throat, almost as wide as long, lobes short, rounded and slightly notched; stamens exserted; style slightly puberulent, exserted, not swollen at the base, stigma-lips ovate, acute, nearly equal, ciliate; capsule 1.5 cm. long; seeds oval, apiculate at both ends, muriculate.

Distribution: known only from the southwestern part of San Diego Co., California.

Specimens examined:

California: dry ridges, Jacumba, 31 May, 1903, *Abrams 3656* (N. Y., TYPE, G, M, Stanford, and Pomona); El Cajon, San Diego Co., Aug., 1889, *Orcutt* (M).

111. M. stellatus (Kell.) Grant, comb. nov.

Diplacus stellatus Kell. in Proc. Calif. Acad. Sci. **2**: 18. 1863, and **2**: 210. 1885; Greene in Bull. Calif. Acad. Sci. **1**: 95. 1885.

Diplacus glutinosus var. *stellatus* (Kell.) Greene, Pittonia **2**: 155. 1890.

A scraggly freely branching shrub, the young stem and branches densely covered with deep-yellow tomentum; leaves numerous, ovate-lanceolate to linear, 2–4.5 cm. long, .3–1.2 cm. wide, obtuse, entire or occasionally denticulate, tapering to a broad sessile base, revolute, thick, glabrous and shining above, densely orange-pubescent below with branched hairs; pedicels stout, 6–7 mm. long; calyx narrow, tubular, 2–2.2 cm. long, glabrous or sometimes puberulent, very glutinous, little or not inflated above, teeth linear, obtuse, ciliate, the longest 5–6 mm. long; corolla 3.5–3.8 mm. long, yellow, puberulent externally, tube slender, included, throat funnelform, lobes narrow, 3–5 mm. long, rounded, not erose; stamens unequally inserted near the top of the tube, longer pair exserted; style exserted, swollen at the base; capsule included; seeds oblong, apiculate at each end, faintly reticulate.

Distribution: known only from Cedros Island, off the coast of Lower California.

Specimens examined:

Lower California: Cedros Island, May, 1885, *Greene* (G, M, and

Stanford); Cedros Island, May, 1881, *Belding* (G); Cedros Island, 18–20 March, 1889, *Edw. Palmer 728* (G); Cedros Island, July–Oct., 1896, *Anthony 47* (G and Stanford); Cedros Island, 1 April, 1897, *T. S. Brandegee* (U. S. and M); Cedros Island, without date, *Veatch* (G, *type collection*).

Dr. Kellogg and Dr. Greene were much confused regarding this species; Dr. Kellogg gave it its specific name because of certain stellate hairs which were found on the pedicels and on the lower surface of the leaves. Later, it was found that these hairs belonged to another plant which grew near the *Mimulus*. *D. stellatus* was accordingly reduced to synonymy under *Mimulus* by Dr. Gray and to a variety of *Diplacus glutinosus* by Dr. Greene. The dense orange-yellow pubescence, though, is characteristic of the plant and differentiates it from the other members of the section. This and its small corolla with an unusually narrow funnelform throat and short lobes seem to warrant its being retained as a valid species.

112. M. aurantiacus Curt. in Bot. Mag. I. **10**: *pl. 354*. 1796.

M. glutinosus Wendl. Bot. Beobacht. 51. 1798; Jacq. Hort. Schoenbr. **3**: *pl. 364*. 1798; Willd. Sp. Pl. **3**: 361. 1800; Benth. Scroph. Ind. 28. 1835; Hook. & Arn. Bot. Beechey's Voyage. 154. 1841; Gray in Bot. Calif. **1**: 565. 1876; Syn. Fl. N. Am, **2**^{1}: 275. 1878, ed. 2, and Suppl. 442. 1886. Pl. 10, figs. 5, 14.

M. viscosus Moench, Meth., Suppl. 168. 1802.

Diplacus glutinosus Nutt. in Taylor's Ann. Nat. Hist. I. **1**: 138. 1838, by error published as *D. glutinosa;* Nutt. ex Hooker in Curtis, Bot. Mag. II. **12**: under *pl. 3655*. 1838; Benth. in DC. Prodr. **10**: 368. 1846; Greene in Bull. Calif. Acad. Sci. **1**: 95. 1885; Pittonia **2**: 154. 1890; Manual Bay Region, 274. 1894; Howell, Fl. Northwest Am. 518. 1901; Jepson, Fl. W. Mid. Calif. 402. 1901, and ed. 2, 376. 1911.

Diplacus aurantius Sweet, Hort. Brit. ed. 2, 516. 1839.

Diplacus latifolius Nutt. in Taylor's Ann. Nat. Hist. I. **1**: 138. 1838, by error published as *D. latifolia;* Nutt. ex Hooker in Curtis, Bot. Mag. II. **12**: under *pl. 3655*. 1838; Greene in Bull. Calif. Acad. Sci. **1**: 95. 1885.

Diplacus glutinosus var. *aurantiacus* (Curt.) Lindl. in Paxt. Fl.

Gard. 3: under *pl. 92.* 1851–53; Planchon in Fl. des Serres 9: under *pl. 883.* 1853–54.

Diplacus glutinosus var. *latifolius* Greene, Pittonia 2: 155. 1890.

A profusely branched scraggly shrub, 6–12 dm. high; upper part of stem yellowish, puberulent or pubescent, often with some short glandular hairs; leaves sessile, oblong to lanceolate or linear, 2.5–5 cm. long, 4–14 mm. broad, entire, few-toothed or sometimes serrate, revolute, dark green, glabrous and shining above, covered with numerous small compound sessile glands, paler and usually with a dense branched pubescence beneath, smaller leaves often fascicled in the axils; pedicels mostly shorter than the calyx, .4–1 cm. long, glandular-pubescent; calyx narrow, 2–2.8 cm. long, 3–5 mm. broad, tubular, not constricted at the center and little or not at all inflated at the orifice, glabrous or sometimes puberulent, rarely pubescent, sometimes hispid at the sinuses, teeth triangular, obtuse, 2–5 mm. long, covered with sessile glands; corolla 3.5–4 cm. long, yellow, tube mostly included, sometimes slightly puberulent externally, enlarging gradually to a wide funnelform throat, lobes spreading, unequal, mostly truncate, sometimes emarginate or erose; stamens slightly exserted; style-base enlarged in maturity, stigma-lips rounded, ciliate, usually exserted; capsule about as long as the calyx; seeds long-oblong, apiculate at both ends, papillose.

Distribution: common in the foothills of the Sierra Nevada and Coast Range Mts., from southern Oregon to Santa Barbara Co., California.

Specimens examined:

Oregon: Brookings, Curry Co., May, 1915, *Thompson 116* (Stanford); open bluff above beach, Brookings, 11 July, 1919, *Peck 8786* (M).

California: Fort Bragg, Mendocino Co., 8–16 Aug., 1912, *Eastwood 1676* (Calif.); Fort Bragg, 1914, *Mathews 30* (Calif.); Big River, Mendocino Co., June, 1903, *McMurphy 294* (Stanford); Mendocino, May, 1896, *H. E. Brown, 703, 834* (M); Carlotta, Humboldt Co., June, 1915, *Hawver* (Calif. Acad.); Trinidad, Humboldt Co., 21 April, 1907, *Eastwood 6* (Calif. Acad.); Eureka, 28 April, 1918, *Paulson* (Stanford); Trinidad,

18 July, 1916, *Abrams 6141* (Stanford); Fortuna, Humboldt Co., 18 July, 1916, *Abrams 6072* (Stanford); Bartlett Springs, *McCallum* (Calif. Acad.); banks of Smith River, 21 April, 1892, *Howell 1454* (M); Smith River, Del Norte Co., June, 1884, *Howell* (G); near American Lower Bridge at Folsom, 7 April, 1916, *Heller 12305* (M, Stanford, and Calif. Acad.); 4 miles above Folsom, 14 April, 1918, *Hannibal* (Stanford); between Folsom and Auburn, 27 April, 1918, *Hannibal* (Stanford); Petaluma, 14 June, 1895, *Tidestrom* (Pomona); Lakeport, Lake Co., 28 March, 1917, *Bentley* (Stanford); Gates Canyon, near Vacaville, 27 April, 1902, *Heller & Brown 5388* (Cornell, M, Stanford, and Pomona); Vaca Valley, 1877, *Rattan* (Stanford); near St. Helena Sanitarium, 2 July, 1916, *Abrams 5769* (Stanford); Petrified Forest, Sonoma Co., 3 July, 1916, *Abrams 5780* (Stanford); Bodega Bay, Sonoma Co., 11 April, 1902, *Heller & Brown 5258* (M); vicinity of Ione, Amador Co., 200–500 ft. alt., July, 1904, *Braunton 1146* (M); Comanche, 300 ft. alt., April, 1895, *Hansen 1052* (M); White Bar, 1000 ft. alt., April, 1895, *Hansen 1051* (M); Plymouth, Amador Co., 1 June, 1903, *Gross 79* (Stanford); Mokelumne Hill, 1300 ft. alt., May, 1895, *Blaisdell* (Calif. Acad.); near Rawhide, Tuolumne Co., 13 Aug., 1915, *Stinchfield 81* (Stanford); Kentfield, Marin Co., 20 May, 1912, *Eastwood 66* (Calif. Acad.); Sausalito, 12 Aug., 1872, *Redfield 6093* (M); Lone Mt., San Francisco, 1877, *Rattan* (Stanford); Sunnyside, San Francisco, 1892, *Cannon* (Calif. Acad.); San Francisco, *Bolander 0/4* (M); sand dunes, San Francisco, 5 June, 1893, *Davy 196* (M); San Mateo, 21 April, 1894, *Burnham* (Pomona); East Oakland hills, July, 1899, *Carruth* (Calif. Acad.); Berkeley, 1891, *Greene* (Stanford); Cedar Mt., Alameda Co., May, 1903, *Elmer 4355* (M); Sunol Valley, Alameda Co., 29 June, 1916, *Abrams 5682* (Stanford); Mocho Creek, Alameda Co., May, 1903, *Elmer 4355* (Stanford, Calif. Acad., and Pomona); Mt. Diablo, near lake, 30 June, 1916, *Abrams 5704* (Stanford); Mt. Diablo, 30 May, 1915, *Eastwood 4455* (Calif. Acad.); San Leandro, 21 June, 1915, *Eastwood 4737* (Calif. Acad.); Belmont, 6 May, 1911, *Nichols 1006* (Stanford); Templeton, 1 July, 1911, *Thompson 1001, 1002* (Stanford); Congress Springs, 29 April, 1911, *Nichols 831*

(Stanford); Stanford University, 17 April, 1902, *Abrams 2346* (Stanford and M); Page Mill Road, foothills near Stanford University, 23 April, 1904, *Anthony* (Stanford); Stanford University, May, 1902, *Dudley* (Stanford); foothills near Stanford University, 2 March, 1902, *C. F. Baker 280* (M and Pomona); foothills west of Los Gatos, 25 May, 1904, *Heller 7449* (M and Stanford); Saratoga, Big Basin Road, 23 June, 1915, *Abrams 5257* (Stanford); King's Mt., Santa Cruz Mts., 20 May, 1906, *McMurphy 25* (M); Santa Cruz, 16 June, 1903, *Thompson* (M); Glenwood, Santa Cruz Co., 1914, *Davis* (Calif. Acad.); Pt. Pinos, Monterey, 30 May, 1912, *Eastwood 185* (Calif. Acad.); Pacific Grove, 17 June, 1916, *McGregor 66* (Stanford); hard road bed, Pacific Grove, 5 Nov., 1911, *Nichols 1008* (Stanford); in pine woods, Huckleberry Hill, near Pacific Grove, 30 Sept., 1905, *Dudley* (Stanford); woods near Pacific Grove, 12 June, 1907, *Patterson & Wiltz* (Stanford); open pine forest, Pacific Grove, Aug., 1917, *Parish 11502* (M); in pine woods, Pacific Grove, 14 April, 1903, *Heller 6580* (M, Stanford, and Pomona); Pacific Grove, June, 1903, *Elmer 4377* (M, Stanford, and Pomona); Carmel Valley, 25 June, 1905, *Dudley* (Stanford); on north side of Carmel Valley, 1 June, 1916, *Abrams 5631* (Stanford); Coast Trail, Monterey Co., 17 Aug., 1903, *Dudley* (Stanford); Santa Margarita Mts., on road to San Luis Obispo, 3 April, 1903, *Dudley* (Stanford); Cuesta Grade, San Luis Obispo Co., 20 July, 1913, *Abrams 5042* (Stanford); Haynes Ranch, San Luis Obispo Co., July, 1912, *Ingalls* (Calif. Acad.); San Luis Obispo Hot Springs, 10 June, 1917, *Abrams 6509* (Stanford); Pismo, San Luis Obispo Co., 1 April, 1911, *Dice* (Stanford); Suey Creek, Santa Maria, 15 June, 1916, *Eastwood 433* (Calif. Acad.); Gaviota Pass, Santa Barbara Co., 11 June, 1917, *Abrams 6540* (Stanford); Fremont's Expedition to California, 1846, *Fremont 509* (M).

M. aurantiacus, being the earliest published name, has undoubted priority and therefore must be substituted for the well-known name of *M. glutinosus*. This species is found north of the northern part of Santa Barbara Co., whereas *M. longiflorus* to which it is closely related, is mostly confined to the southern part of the state. A few specimens seem to suggest an intermediate

condition, and it is possible that they hybridize where they meet. *Diplacus latifolius* Nutt. is a broad-leaved form of *M. aurantiacus.* A pubescent form has been collected by *Abrams 6467, 6468, 6469,* and *6470* and by *Dudley* on the road between Jolon and King's City in central California. In these specimens, the stem, branches, pedicels, and calyces are densely pubescent.

113. **M. puniceus** (Nutt.) Steud. Nom. Bot. ed. 2, pt. 2, 150. 1841; Gray, Syn. Fl. N. Am. ed. 2, 2^1: Suppl. 442. 1886.

Pl. 10, fig. 11.

Diplacus puniceus Nutt. in Taylor's Ann. Nat. Hist. I. **1**: 137. Apr., 1838, by error published as *D. punicea;* Nutt. ex Hooker in Curtis, Bot. Mag. II. **12**: under *pl. 3655.* May, 1838; Maund's Botanist **4**: *pl. 169.* 1840; P. N. Don in Donn's Hort. Cantab. ed. 13, 402. 1845; Greene in Bull. Calif. Acad. Sci. **1**: 96. 1885; Pittonia **2**: 157. 1890; Abrams, Fl. Los Angeles, 364. 1904, and ed. 2, 334. 1917.

Diplacus glutinosus var. *puniceus* Benth. in DC. Prodr. **10**: 368. 1846.

M. glutinosus var. *puniceus* Gray in Bot. Calif. **1**: 566. 1876; Syn. Fl. N. Am. 2^1: 275. 1878, and ed. 2, 1886.

A freely branched glutinous shrub, 5–18 dm. high; stem and branches terete, glabrous or puberulent; leaves thick, linear or narrowly lanceolate, occasionally oblanceolate, 2–6 cm. long, 3–11 mm. broad, mostly obtuse, usually sessile and partly clasping the stem, entire or sometimes denticulate, generally revolute, dark green and glabrous above, paler and with scattered branched hairs on the lower surface, smaller leaves often fascicled in the axils; pedicels 6–12 mm. long; calyx narrow, tubular, 1.8–2.5 cm. long, glabrous, throat scarcely dilated, teeth triangular, obtuse or acute, often ciliate, unequal, upper tooth 5–7 mm. long; corolla 3.5–4 cm. long, dark red to brick-red, tube included, throat ample, funnelform, lobes narrow, truncate, emarginate or the lateral lobes irregularly notched; stamens inserted on the upper part of the tube, longer pair sometimes puberulent, usually slightly exserted; style exserted, puberulent above, slightly thickened at the base at maturity; stigma-lips equal; capsule cylindrical, obtuse, nearly as long as the calyx; seeds elliptical, acute at both ends, papillate.

Distribution: common on dry hillsides from Los Angeles Co. to northern Lower California.

Specimens examined:

California: Avalon, Santa Catalina Island, 13 June, 1915, *Carlson* (G); Santa Catalina Island, 22 April, 1904, *G. B. Grant 285* (M and Deam); Santa Catalina Island, 20–25 July, 1917, *Eastwood 6502* (Calif. Acad.); Avalon, Santa Catalina Island, Aug., 1896, *Trask* (M); Avalon, Santa Catalina Island, 8 April, 1901, *G. B. Grant 3753* (Stanford); Catalina Island, 23 July, 1915, *Drushel* (M and Drushel); Encinitas, May, 1894, *Angier 34* (M); moist hillsides, Laguna Cañon, 26 July, 1916, *Crawford* (M and Pomona); La Crescenta, *Wislizenus 1291*, in part (M); dry hillsides, Temecula, 27 April, 1918, *Munz 2145* (Pomona); Butte, west of Lakeview, 2000 ft. alt., 8 May, 1920, *I. M. Johnston 2284, 2298* (M and Pomona); Miller's Canyon, Murietta, 28 March, 1916, *Robinson* (Pomona); Sierra Canyon, Santa Ana Mts., 1200 ft. alt., 24 April, 1920, *Munz & Harwood 3758* (M and Pomona); Mission Hills, San Diego, 9 May, 1903, *Abrams 3440* (M and Stanford); near Fallbrook, San Diego Co., 750 ft. alt., 17 May, 1920, *Munz & Harwood 3853, 3854* (M and Pomona); along north hillsides, San Diego, 10 June, 1902, *T. S. Brandegee 1640*, distributed as *C. F. Baker 1640* (M and Pomona); Elsinore, 4 April, 1904, *C. F. Baker 4152* (M, Stanford, Calif. Acad., and Pomona); dry hillsides, San Luis Valley, 5 May, 1917, *Street* (Pomona); hills near Ysidora, San Diego Co., 23 April, 1903, *Abrams 3285* (M and Stanford); chaparral, Howard Canyon, La Jolla, 7 Mar., 1914, *Clements & Clements 122* (M); Del Mar, 9 June, 1901, *Jepson 1604a* (Calif.); near San Diego, May, 1889, *T. S. Brandegee* (G and M); San Diego, 1850, *Parry* (M); San Diego, 1875, *Edw. Palmer 283* (M); San Diego, 1879, *Orcutt 131* (M); in canyons near San Diego, 400 ft. alt., 11 June, 1920, *Spencer 1617* (Pomona); Sweetwater Dam, 20 April, 1895, *Fritchey* (M); Geological Survey of California, 1860–1861, *Cooper* (G and U. S.); San Clemente Island, June, 1903, *Trask 267* (U. S., a thin and broad-leaved form); San Clemente Island, 10 April, 1923, *Munz 6707* (Pomona, similar to the above); San Diego, without date, *Nuttall* (G, TYPE).

Mexico:
Lower California: northern Lower California, 23 June, 1885, *Orcutt 1295* (Gray Herb.).

114. M. parviflorus (Greene) Grant, comb. nov.

Diplacus parviflorus Greene, Pittonia **1**: 36. 1887; *ibid.* **2**: 157. 1890; Davy in Gard. Chron. III. **16**: 20. 1894.

A very leafy shrub, glabrous or nearly so, 1.5–6 dm. high; leaves obovate or rhombic-ovate, 2–4.5 cm. long, .5–2 cm. broad, obtuse, narrowed to a slender sessile base, entire or irregularly dentate, occasionally revolute, paler green on lower surface and often shining as though varnished; flowers numerous, pedicels mostly as long as the calyx, slender; calyx tubular, 1.7–2.2 cm. long, slightly spreading at the throat, covered with sessile glands, these giving it a shiny appearance, teeth short, triangular, obtuse, upper one 4–6 mm. long; corolla 2.5–4 cm. long, brick-red, tinged with yellow on lower lip and down the throat, tube slender, included, expanding abruptly to the long, somewhat tubular throat, lobes short, truncate, little spreading, scarcely erose, upper lip 5–6 mm. long, lower lip shorter, limb 1–1.5 cm. in diameter; stamens exserted, upper pair often as long as the corolla; style and stigma reddish-yellow, exserted, sometimes with a slight tubercular enlargement at the base; stigma-lips ciliate, sometimes fimbriate; capsule 1.5–2 cm. long; seeds oval, apiculate at each end, reticulate.

Distribution: common on Santa Cruz Island off the coast of Santa Barbara, California.

Specimens examined:

California: Island of Santa Cruz, July and August, 1886, *Greene* (M, Phil., and Stanford); Santa Cruz Island, April, 1888, *T. S. Brandegee* (G); East End Mt., Santa Cruz Island, July, 1901, *Snodgrass* (Stanford); Friar's Harbor, Santa Cruz Island, 3 Sept., 1903, *J. Grinnell 7* (Stanford); Santa Cruz Island, 16–17 July, 1917, *Eastwood 6397* (G and Calif. Acad.); Santa Cruz Island, 24 May, 1918, *Miller* (Calif. Acad.); Valdez Harbor, Santa Cruz Island, Aug., 1923, *A. L. Grant 1696* (M and Calif.).

Dr. Greene reports that these plants "flower profusely at a height of only three or four inches."

An interesting plant, closely related to *M. parviflorus*, has been collected on Santa Cruz Island by *Mrs. C. E. Miller* and *A. L. Grant 1703* and *1704*. A single specimen first came to the author's notice in a collection of *Mimulus* borrowed from the California Academy of Science. In July, 1923, there was an opportunity to go to Santa Cruz Island to look for this plant. It was found to be fairly common on the open hillsides near Friar's Harbor and Valdez, occurring, however, only where *M. parviflorus* and *M. longiflorus* grew near each other. The color varied from the deep red of *M. parviflorus* to the clear yellow of *M. longiflorus*. The shape and size of the calyx and corolla and the leaf characters exhibited all possible combinations of the characters of the two above-mentioned species, so it seemed probable that the plants under consideration were natural hybrids. Typical material of *M. parviflorus* was found to be abundant in the canyons, whereas typical *M. longiflorus* occurred only on the open hillsides Crosses are being made between these several plants, and it is hoped to obtain experimental proof of the parentage of the apparent hybrid.

Doubtful and Little-Known Species

M. albus Dougl. Jour. 150. 1914.

Stem 10–15 cm. high; leaves sessile, linear-lanceolate, minutely dentate; flowers small, white, tube yellow.

Collected by Douglas on the shores of the Columbia River. This probably is an albino form of *M. breviflorus* or of one of the species closely allied to it.

M. glandulosus Lehm. Del. Sem. Hort. Hamb. 7. 1830; Linnaea **6**: Litt. 11. 1831; Walp. Rep. **3**: 276. 1844–45.

A glandular-pubescent annual with procumbent stems; leaves broadly ovate, dentate, pale green; pedicels shorter than the leaves; flowers small.

Indigenous to North America. It evidently is closely related to *M. glabratus* and may be a pubescent form of that species.

M. lanatus Dougl. Jour. 122. 1914; Loudon in Hort. Brit. 251. 1839, not Pursh (inadequately described).

A woolly perennial with creeping roots; leaves nearly sessile, ovate-lanceolate; flowers large, yellow.

Collected by Douglas on moist rocks on the Multnomah and Columbia Rivers at the falls of both.

M. orizabae Benth. in DC. Prodr. **10**: 372. 1846.

Pubescent; leaves subcordate-ovate, about 2.5 cm. long, serrate, sparsely hirtellous, petiolate; pedicels longer than the leaves; calyx-teeth broadly lanceolate, the upper larger; corolla twice as long as the calyx.

Collected on Mt. Orizaba in Mexico.

M. pteropus Raf. Fl. Ludov. 44. 1817.

The brief description corresponds closely with some of the short-petioled specimens of *M. alatus.* Rafinesque says, however, that it "is not the *M. alatus* which has winged stems and sessile flowers."

M. Pissisi Phil. in Anal. Univ. Chile **18**: 57. 1861; Linnaea **33**: 212. 1864–65.

M. depressus var. *Pissisi* (Phil.) Reiche, Fl. Chile **6**[1]: 62. 1911.

Glabrous; stems creeping, very short, stoloniferous; leaves crowded, sessile, triangular-ovate, 1 5 cm. long, 1.2 cm. broad, coarsely and doubly dentate, sometimes dotted with red; flowers subsessile; calyx-teeth broad; corolla 2.6 cm. long, not spotted; style as long as the corolla.

Four specimens of this species were collected by Volkmann at Huanta in the Province of Coquimbo, Chile, at 4000 ft. alt. It may be conspecific with *M. luteus.*

M. punctatus Miers ex Bert. in Merc. Chile, 700. 1829; Am. Jour. Sci. **23**: 254. 1833.

A species imperfectly described and possibly a synonym of one of the varieties of *M. luteus.* It has large yellow flowers with red spots.

M. Neubertii Hge. & Schm. ex Wettst. in Engl. & Prantl, Nat. Pflanzenfam. **4**[3b]: 72. 1891, *nomen nudum.*

Mimulus quinquevulnerus is the French florist's name for *M. luteus*, fide Morren in Belg. Hort. **20**: 177. 1870.

HYBRIDS

Mimulus was very popular in horticulture during the middle part of the nineteenth century. The ease with which hybrids could be obtained and the great variety of color-forms which resulted made it a desirable group for experimental purposes. The most common parents were *M. luteus* and its varieties *rivularis* and *variegatus* of the section *Simiolus*, *M. cardinalis* and *M. Lewisii* of the sections *Erythranthe* and *Paradanthus*, and *M. glutinosus* and *M. puniceus* of the section *Diplacus*. Numerous hybrids were produced and these were crossed and recrossed, so that it is impossible to tell the parentage of most of the present garden forms. It is interesting to note that no hybrids were recorded from crosses made between members of the section *Diplacus* and any other section. The following is a list of the more common hybrids which have been described and pictured in various floral magazines. Many of them are still being cultivated.

M. cornation Rivoire in Rev. Hort. **93**: 355. 1921.
Corolla velvety-red, throat yellow. Derived from *M. cupreus*.

M. Bartonianus Rivoire in Rev. Hort. **93**: 356. 1921.
Flowers rose-red, throat yellow spotted with brownish-red. Hybrid between *M. cardinalis* and *M. Lewisii*.

M. duplex Hort. ex Wettst. in Engl. & Prantl, Nat. Pflanzenfam. 4^{3b}: 72. 1891.

M. Elphinstonea in Fl. Mag. **4**: 144. 1836.
The colored plate shows the plant to have yellow corollas, each lobe of which is deeply edged with crimson. Parentage not given.

M. Forsythiana in Fl. Mag. **3**: 216. 1835.
Flowers pale-sulphur with rosy-crimson spots. This hybrid was raised by J. Forsyth, of Anlaby, near Hull. Parentage not given.

M. Harrisonia Paxt. in Paxton's Mag. Bot. **4**: 173. 1838.
Corolla reddish-pink with lines of reddish-brown spots down the throat below each lobe, lobes not reflexed. This is a hybrid between *M. cardinalis* and *M. roseus*.

M. hybridus Hort. ex Wettst. in Engl. & Prantl, Nat. Pflanzenfam. 4[3b]: 72. 1891.

M. luteus var. **calycanthemus** Morr. in Belg. Hort. **20**: 177. *pl. 9.* 1870.

This is a double form with the calyx similar to the corolla. Flowers yellow streaked and spotted with red. According to Morren it appeared spontaneously on a plant which was the result of a cross between *M. cupreus* and *M. trigridioides.*

M. luteus var. **pardinus** Morr. in Belg. Hort. **17**: 77. 1867.

This is another one of the forms with double flowers. It was received by Benary at Erfurt and was called by him *M. tigrinus* var. *duplicis.* It is descended from seed of *M. maculosus* which was the result of a cross between *M. cupreus* and a hybrid of *M. luteus* under the name of "Gaiety."

M. luteus var. **Wilsoni** D. Don in Brit. Fl. Gard. *pl. 406.* 1838; Paxt. Mag. Bot. **4**: 260. 1838.

Corolla yellow with numerous dark fulvous-red spots. This is said to have been raised by Miss Wilson from seeds of *M. luteus.*

M. Maclainianus (Hook.) Paxt. in Mag. Bot. **9**: *pl. 147.* 1842.

M. roseus var. *Maclainianus* Hook. in Bot. Mag. *pl. 3924.* 1842; Paxt. Mag. Bot. **9**: 46. 1842.

Resembles *M. cardinalis* closely in the shape of the flower. Corolla deep crimson with a deep blood-red center. This is a hybrid between *M. roseus* and *M. cardinalis.*

M. maculatus Paxt. in Paxt. Mag. Bot. **4**: 119. 1838.

Corolla yellow with spots of delicate pink color. Parentage not given.

M. maculosus in Gartenfl. **13**: 153. 1846.

Corolla large and variously spotted and lined. Hybrid between *M. luteus* or some of its hybrids and *M. cupreus.*

M. rubiginosus Morr. in Belg. Hort. **10**: 268. 1860.

Said to be similar to *M. quinquevulnerus,* which was the French florist's name for *M. luteus.*

M. sanguineus Paxt. in Paxt. Mag. Bot. **4**: 119. 1838.

Corolla red. Parentage not given.

M. Seymouriana Paxt. in Paxt. Mag. Bot. **9**: 118. 1842.

Corolla large, the lobes marked with blotches or bands of brown around a yellow center, these bands being stained or clouded with a darker color. Parentage not given.

M. Smithii Paxt. in Paxt. Mag. Bot. **1**: *pl. 54.* 1834; Bot. Reg. *pl. 1674.* 1835.

Leaves large, covered with white glandular hairs; pedicels about three times as long as the calyx; corolla yellow with a single large reddish-brown spot near the tip of each petal, throat dotted with red. This is a cross between *M. luteus* var. *rivularis* and *M. variegatus.*

M. tigridioides Hort.

This is a garden name for many of the numerous color forms resulting from various crosses, mostly between *M. luteus* or its varieties and *M. cupreus.*

M. Youngii Hort. Angl. ex Steud. Nom. ed. 2, 150. 1841.

Diplacus Godroni Versch. ex Morr. in Belg. Hort. **13**: 4. 1863.

D. glutinosus var. *Godroni* Lem. in L'Illust. Hort. **10**: *pl. 359, fig. 1.* 1863.

Flowers large, corolla dark red, throat and base of lobes yellow, lobes fringed. This is the result of a cross between *D. aurantiacus* and *puniceus* with *D. glutinosus,* according to the authors.

Diplacus splendidus Versch. ex Morr. in Belg. Hort. **13**: 5. 1863.

D. glutinosus var. *splendidus* Lem. L'Illust. Hort. **10**: *pl. 359, fig. 3.* 1863.

Flowers large, corolla dark red, throat and tube yellow, lobes dark red, emarginate. This is the result of the same cross as the above.

Diplacus Verschaffeltii Versch. ex Morr. in Belg. Hort. **13**: 5. 1863.

D. glutinosus var. *Verschaffeltii* Lem. in L'Illust. Hort. **10**: *pl. 359, fig. 2.* 1863.

Flowers smaller than in either of the above, corolla deeper red, tube yellow, throat yellow with two white ridges below the middle

lobe, lobes more narrow, margin irregular but not incised nor fringed. This is the result of the same cross as the above.

Fossil Species

M. saxorum Cockerell in Am. Mus. Nat. Hist. Bull. **24:** 107. *pl. 10, fig. 47.* 1908.

Pedicels 6.5 mm. long; calyx 18 mm. long, teeth sharply pointed, upper and lower teeth 6 mm. long, lateral teeth 5 mm. long.

This is a well-preserved specimen from the Tertiary and was discovered in Colorado. Cockerell says that it has a calyx formed "approximately as in *M. guttatus.*" In that species, however, the teeth are broadly rounded and the upper one is two to three times as long as the others. The fossil calyx seems to be more nearly related to *Tropanthus* or to *Eumimulus.*

Excluded Species

Mimulus Alecterolophus Scop. Fl. Carn. ed. 2, **1:** 435. 1772 = Rhinanthus Crista-galli L.

Mimulus Crista-galli Scop. Fl. Carn. ed. 2, **1:** 434. 1772 = Rhinanthus Crista-galli L.

Mimulus exilis Dur. & Hilg. in Pac. Rail. Rept. **5:** 12. *pl. 12.* 1855 = Mimetanthe pilosa (Benth.) Greene.

Mimulus hirsutus Blume, Bijdr. 756. 1825–26 = Torenia flava Buch.-Ham.

Mimulus javanicus Blume, Cat. Hort. Buitenz. 83. 1823 = Vandellia crustacea Benth.

Mimulus perfoliatus HBK. Nov. Gen. & Sp. **2:** 371. 1817 = Leucocarpus alatus D. Don.

Mimulus pilosus Wats. in Bot. King's Exp. 225. 1871 = Mimetanthe pilosa (Benth.) Greene.

Mimulus radicans Hook. f., Fl. N. Zeal. **1:** 188. 1853–55 = Mazus radicans (Hook. f.) Cheesm.

Mimulus violaceus Blanco in Fl. Filip. ed. 2, 357. 1845 = Vandellia mollis Benth.

Diplacus rugosus Benth. in DC. Prodr. **10:** 368. 1846 = Berendtia rugosa (Benth.) Gray.

List of Exsiccatae

The distribution numbers are printed in *italics*. Unnumbered collections are indicated by a dash. The number in parentheses is the species number used in this monograph.

Abrams, L. R. *813, 1442, 2422, 3877* M. guttatus (14); *1279, 3531, 3597* M. brevipes (70); *1379, 3596* M. Fremontii (77); *1873, 2611, 4380, 4627* M. floribundus (44); *1892, 2588* M. Bigelovii (74); *2346, 5042, 5257, 5631, 5682, 5704, 5780, 6072, 6141, 6509, 6540* M. aurantiacus (112); *2370* M. guttatus var. arvensis (14e); *2543, 4321, 5020, 5033, 6529* M. longiflorus (108), *5350* var. calycinus (108a), *3286* hybrid (108c), *3287, 3716, 4900* var. linearis (108e); *2612, 3538* M. nasutus (17); *2616, 5017, 5485* M. cardinalis (6); *2800, 5836, 6107* M. moschatus var. sessilifolius (46b), *4464* var. longiflorus (46a); *2813, 4571* M. primuloides (54); *3440, 3285* M. puniceus (113); M. aridus (110); *4485* M. laciniatus (18); *4584, 4694* M. Layneae (82); *4695* M. mephiticus (88); *4726* M. Bolanderi (71); *4780* M. Breweri (67); *4932* M. subsecundus var. viscidus (78a); *4950* M. Lewisii (52); —, *5566* M. Douglasii (103); *6901* M. tricolor (98).

Abrams, L. R., & McGregor, E. A. *55* M. longiflorus (108); *99* M. Fremontii (77); *464* M. Bigelovii (74); *530* M. cardinalis (6); *559* M. Parishii (51); *648* M. moschatus var. longiflorus (46a).

Aguiel, Bro. *10254* M. glabratus var. Fremontii (25a).

Aiton, — M. moschatus (46).

Allen, O. D. *72* M. Tilingi var. caespitosus (13a); *276* M. Lewisii (52).

Ames, Alma, *18* M. guttatus (14); *19* M. moschatus var. longiflorus (46a).

Ames, Mrs. M. E. P. — M. angustatus (99); — M. bicolor (55); — M. Douglasii (103); *13* M. Kelloggii (102); *21* M. Pulsiferae (40).

Anderson, C. L. — M. Bolanderi var. brachydontus (71a); —, *73* M. montioides (65).

Anderson, J. P. — M. ringens (1); — M guttatus (14).

Andrews, D. M. *8* M. Tilingi (13).

Angier, B. S. *33* M. brevipes (70); *34* M. puniceus (113); *192* M. guttatus (14).

Anthony, A. W. *39* M. cardinalis (6); *47* M. stellatus (111).

Anthony, G. — M. aurantiacus (112).

Applegate, E. I. — M. brevipes (70).

Arimoto, — M. nepalensis (35).

Arsène, Bro. — M. glabratus (25), *5310, 9936* var. Fremontii (25a).

Ashcroft, G. B. — M. alatus (2).

Atkinson, W. A. — M. aurantiacus (112).

Austin, Mrs. R. M. *16* M. Austinae (84); *85, 1543* M. guttatus var. depauperatus (14b); *146* M. angustatus (99); *147*, —, *395* M. moschatus var. longiflorus (46a); *159, 213* M. glaucescens (15); *160*, — M. primuloides (54); *162* M. Torreyi (81); *163* M. bicolor (55); *164* M. latidens (31); *227* M. Douglasii (103); — M. leptanthus (109).

Austin, Mrs. R. M., & Bruce, Mrs. C. C. — M. Lewisii (52).

Babcock, H. H. — M. ringens (1).

Bacon, Mrs. G. D. — M. nasutus (17).

Baer, H. — M. diffusus (61).

Bailey, W. W. — M. alatus (2).

Baker, C. F. *30, 200, 554, 1174, 3448, 4214* M. floribundus (44); *253* M. rubellus (69); *280* M. aurantiacus (112); *312, 392, 759, 1060, 1980, 3017, 3808, 3460, 4142, 4259, 4292* M. guttatus (14), *587* var. puberulus (14a), *1058* var. depauperatus (14b), *588* var. Hallii (14c); *515* M. Douglasii (103); *1010, 1375* M. stamineus (90);

1023 M. montioides (65); *1024* M. nanus (83); *1029* M. Suksdorfii (68); *1248* M. Lewisii (52); *1277* M. primuloides (54), *3830* var. linearifolius (54a); *1336*, *3457*, *4291* M. cardinalis (6); *1510* M. Breweri (67); *1640*, *4152* M. puniceus (113); *2608*, in part, M. nasutus (17), *881* var. micranthus (17b); *2923* M. tricolor (98); *3851* M. Layneae (82); *4410* M. mephiticus (88); *4411* M. coccineus (89); *4544* M. Tilingi (13); *5320* M. longiflorus (108), *4407*, *5354* var. calycinus (108a); *5322* M. brevipes (76).

Baker, C. F., Earle, F. S., & Tracy, S. M. *181*, *451*, *819* M. guttatus (14).

Baker, H. B. *30* M. glabratus var. Fremontii (25a).

Baker, M. S. — M. guttatus (14); — M. Pulsiferae (40); *280* M. floribundus (44); *545* M. moschatus var. longiflorus (46a); — M. Breweri (67); — M. Kelloggii (102); — M. longiflorus (108).

Baker, M. S., & Nutting, F. — M. moschatus var. longiflorus (46a); — M. nanus (84); — M. densus (87); *4056* M. mephiticus (88).

Ballard, C. A. — M. ringens (1).

Bancroft, F. W. — M. guttatus var. arvensis (14c).

Barber, J. H. — M. brevipes (70); — M. Fremontii (77); *298* M. longiflorus (108).

Barber, M. A. *11* M. guttatus var. depauperatus (14b), — var. decorus (14d); — M. moschatus (46), *179* var. sessilifolius (46b); *222* M. Lewisii (52).

Barrett, Mrs. — M. guttatus var. depauperatus (14b); — M. washingtonensis (41); — M. Pulsiferae (40).

Barrus, M. F. *71* M. guttatus (14).

Barrus, M. F., & Reed, *115* hybrid (108b).

Barrus, M. F., & Whetsel, M. *209a* hybrid (108b).

Barss, H. P. — M. ringens (1).

Batchelder, — M. longiflorus (108).

Belding, L. — M. stellatus (111).

Bendire, — M. nanus (83).

Bentley, G. — M. Kelloggii (102); — M. Douglasii (103); M. aurantiacus (112).

Bereman, S. D. *761* M. Tilingi (13).

Berg, N. K. *10* M. moschatus var. sessilifolius (46b).

Bergman, H. F. *2290* M. glabratus var. Fremontii (25a).

Bergman, T. S. — M. alatus (2).

Berlandier, J. L. *781* M. glabratus (25).

Bertero, D. *437*, —, *1148* M. luteus var. variegatus (10b).

Beyrich, H. K. — M. ringens (1).

Bidwell, J. — M. tricolor (98); — M. Douglasii (103).

Bioletti, F. T. — M. nasutus var. insignis (17a); — M. Bioletti (56); — M. pulchellus (100).

Bischoff, F. — M. guttatus (14).

Bixby, S. P. — M. Fremontii (77).

Blaisdell, F. E. — M. aurantiacus (112).

Blanchard, F. — M. ringens (1).

Blankinship, J. W. — M. ringens (1); *389* M. guttatus (14); — M. glabratus var. Fremontii (25a);—M. moschatus (46); *390* M. Lewisii (52).

Blasdale, W. C. — M. dentatus (38); — M. Lewisii (52).

Blumer, J. C. *1399*, *3433* M. guttatus (14); *1551* M. cardinalis (6).

Boettcher, F. L. J. *245* M. ringens (1).

Bolander, H. N. *96* M. cardinalis (6); — M. bicolor (55); 0/4 M. aurantiacus (112); *4521* M. Kelloggii (102); *4690* M. angustatus (98); *4796* M. Douglasii (103); — M. leptanthus (109); *4872* M. primuloides (54); *6016* M. leptaleus (91); *6311* M. Breweri (67); *6314* M. Bolanderi (71); *6316* M. Suksdorfii (68).

Bolander, H. N., & Kellogg, A. — M. Pulsiferae (40).

Bolton, A. L. — M. leptanthus (109).

Boorman, J. L. — M. prostratus (28).

Bowman, A. *2* M. tricolor (98); *21* M. Douglasii (103); *219* M. Bolanderi var. brachydontus (71a).

Brandegee, K. — M. guttatus (14);—

M. nudatus (16); — M. nasutus (17); — M. glabratus var. Fremontii (25a); — M. latidens (31); — M. Grayi (33); — M. floribundus var. geniculatus (44a); — M. moschatus var. sessilifolius (46b); — M. subsecundus var. viscidus (78a); — M. Rattanii (80); — M. Layneae (82); — M. densus (87); — M. mephiticus (88); — M. mohavensis (94); —, *168* M. tricolor (98); — M. modestus (101); — M. Clevelandii (107); — M. longiflorus (108), — var. calycinus (108a), — var. linearis (108e); — M. aurantiacus (112).

Brandegee, T. S. *71* M. guttatus (14); — M. nudatus (16); — M. nasutus (17); — M. glabratus var. Fremontii (25a); *206* M. breviflorus (30); — M. inconspicuus (34); — M. latidens (31); —, *206a*, *515* M. floribundus (44), — var. geniculatus (44a); *226* M. Lewisii (52); — M. bicolor (54); — M. diffusus (61); — M. purpureus var. pauxillus (62a); — M. discolor (64); — M. Fremontii (77); — M. latifolius (95); — M. angustatus (99); — M. Kelloggii (102); — M. Clevelandii (107); — M. stellatus (111); —, *1640* M. puniceus (113); — M. parviflorus (114).

Braunton, E. *472* M. longiflorus var. rutilus (108d); *1146* M. aurantiacus (112).

Brendel, F. — M. glabratus var. Fremontii (25a).

Breninger, E. F. — M. verbenaceus (8).

Brewer, W. H. *586* M. longiflorus (108), *208* var. rutilus (108d); *780* M. subsecundus (78); *953* M. Douglasii (103); *974* M. nasutus var. insignis (17a); *1161* M. latidens (31); *1755* M. primuloides (54); *2144* M. Breweri (67); *2785* M. Whitneyi (93); "*2785* with" M. montioides (65).

Bridges, T. *199* M. Grayi (33); *200* M. Pulsiferae (40); — M. cupreus (11).

Brier, M. — M. leptanthus (109).

Briggs, Mrs. F. F. — M. jungermannioides (45).

Britton, N. L., & Rusby, H. H. *1014* M. glabratus (25).

Broadhead, G. C. — M. guttatus var. depauperatus (14b).

Brown, H. E. *148* M. Douglasii (103); *169*, *842* M. guttatus (14); *183* M. tricolor (98); *198* M. Kelloggii (102); *303* M. Layneae (82); *322* M. Pulsiferae (40); *405*, *669* M. moschatus var. longiflorus (46a); *603* M. primuloides (54); *703*, *834* M. aurantiacus (112); *865* M. cardinalis (6).

Brown, S. *588* M. Lewisii (52); *605* M. Tilingi var. caespitosus (13a); *662* M. moschatus (46).

Brown, V. S., & Wieslander, A. E. — M. moschatus var. longiflorus (46a).

Bruce, Mrs. C. C. *423* M. leptaleus (91); *847* M. densus (87); *859* M. cardinalis (6); *2102* M. Kelloggii (102); *2107* M. tricolor (98).

Bryant, W. — M. latifolius (95).

Buchtien, O. — M. Bridgesii (39).

Buck, — M. luteus var. rivularis (10a).

Buckley, S. B. — M. ringens (1).

Buffum, B. C. *702* M. Lewisii (52); *704* M. guttatus (14).

Burnham, S. H. — M. cardinalis (6); M. guttatus (14), — var. arvensis (14e); — M. arenarius (43); — M. floribundus var. subulatus (44c); — M. Breweri (67); — M. Bolanderi var. brachydontus (71a); — M. subsecundus var. viscidus (78a); — M. aurantiacus (112).

Bush, B. F. *405*, *722*, *921*, *2911*, *5283* M. alatus (2); *1047*, *5320*, *8246* M. ringens (1).

Butler, G. D. *24* M. glabratus var. Fremontii (25a); *1423* M. guttatus (14); *1511*, *1685* M. moschatus var. longiflorus (46a); *1585* M. Layneae (82); *1699* M. primuloides (54), *1770* var. linearifolius (54a); *1733* M. Breweri (67).

Cameron & Lenacker, — M. moschatus var. sessilifolius (46b).

Campbell, M. — M. modestus (101).

Canby, W. W. *35* M. Douglasii (103).

Canby, W. W., & Hammond, H. S. *35* M. Douglasii (103).
Cannon, — M. aurantiacus (112).
Carleton, M. A. — M. alatus (2).
Carlson, J. I. — M. puniceus (113).
Carpenter, A. M. *52* M. Tilingi var. caespitosus (13a); — M. primuloides (54); *53* M. Breweri (67).
Carruth, W. W. — M. aurantiacus (112).
Carter, — M. ringens (1).
Carver, G. W. — M. ringens (1).
Chamberlain, F. M. *44* M. guttatus (14).
Chandler, H. P. *208* M. Layneae (82); *1199* M. dentatus (38); —, *1480* M. Kelloggii (102); *1694* M. guttatus (14).
Chase, A. — M. ringens (1).
Childs, l. J. — M. Johnstonii (75).
Churchill, J. R. — M. guttatus var. depauperatus (14b).
Cipperly, E. M. — M. ringens (1).
Clarke, C. B. *496* M. gracilis (3); *12114* M. nepalensis var. japonica (35a).
Clarke, J. *26*, *290* M. guttatus (14); *162* M. nanus (83); *230* M. moschatus (46); *289* M. floribundus (44).
Clemens, Mrs. J. — M Lewisii (52).
Clements, F. E. *2786* M. ringens (1); *2969* M. glabratus var. Fremontii (25a).
Clements, F. E., & E. S. *122* M. puniceus (113); *125* M. brevipes (70); *126* M. nasutus (17).
Cleveland, D. — M. cardinalis (6); — M. guttatus (14); — M. brevipes (70); — M. longiflorus (108), — hybrid (108c).
Clute, W. N. *128* M. Eastwoodiae (53).
Coghill, G. E. *129* M. guttatus (14).
Cole, K. E. — M. cardinalis (6).
Comstock, S. — M. guttatus var. puberulus (14a).
Congdon, J. W. — M. cardinalis (6); — M. Grayi (33); *C71* M. Pulsiferae (40); — M. floribundus var. geniculatus (44a), — var. subulatus (44c); — M. moschatus (46); — M. Lewisii (52); — M. Bioletti (56); — M. Palmeri (57); — M. filicaulis (58); M. gracilipes (59); — M. Bolanderi (71), var. brachydontus (71a); — M. subsecundus var. viscidus (78a); — M. Torreyi (81); — M. Layneae (82); — M. coccineus (89); — M. stamineus (90); — M. Congdonii (96); — M. tricolor (98); — M. pulchellus (100); — M. Douglasii (103).
Cook, Prof. — M. brevipes (70).
Cooper, J. G. —, *320* M. puniceus (113); — M. primuloides (54); — M. Bigelovii (74).
Cooper, W. S. *61y* M. nanus (83); *404* M. guttatus (14).
Copeland, E. B. *3017*, *3808* M. guttatus (14); *3177* M. glaucescens (15); *3830* M. primuloides var. linearifolius (54a); *3851* M. Layneae (82).
Cotton, J. S. *394* M. guttatus (14).
Coues, E., & Palmer E. *103* M. guttatus (14); *596* M. verbenaceus (8).
Coulter, T. *636* M. Douglasii (103).
Couthouy, J. P. — M. glabratus (25).
Coville, F. V., & Funston, F. *637*, *1524* M. rubellus (69); *740* M. guttatus (14); *1457* M. nasutus (17); *1474* M. primuloides (54); *1625*, *1798* M. stamineus (90); *1768* M. Suksdorfii (68); *1792* M. densus (87); *1855* M. cardinalis (6).
Cowles, H. C. *362*, *1305* M. guttatus (14); *794* M. Tilingi var. caespitosus (13a); *798* M. Lewisii (52).
Cratty, R. I. — M. ringens (1).
Crawford, D. L. — M. cardinalis (6); M. guttatus (14); — M. floribundus (44); — M. puniceus (113).
Criddle, N. — M. glabratus var. Fremontii (25a).
Culbertson (distributed as Baker, C. F.), *4214* M. floribundus (44); *4259*, *4270*, *4292* M. guttatus (14); *4291* M. cardinalis (6); *4407* M. longiflorus var. calycinus (108a); *4410* M. mephiticus (88); *4411* M. coccineus (89); *4544* M. Tilingi (13).
Curran, M. K. — M. nudatus (16); — M. laciniatus (18); — M. latidens (31); — M. floribundus var. geniculatus (44a); — M. bicolor (55); —

M. androsaceus (60); — M. rubellus (69); — M. Bolanderi (71); — M. Rattani (80); — M. angustatus (99); — M. Kelloggii (102); — M. Douglasii (103); — M. pictus (105).
Curtis, A. H. — M. alatus (2).
Curtis, C. D. *68* M. ringens (1).
Cusick, W. C. *1262, 1951, 2630, 2810, 2997, 3009* M. Cusickii (76); *1627* M. nasutus (17); *1727* M. Lewisii (52); *1891, 2236* M. clivicola (85); *2152, 2655* M. nanus (83); *2206* M. guttatus (14); *2237* M. floribundus (44); *2468, 3115* M. Tilingi (13); *2649* M. primuloides (54); *2773, 3116* M. moschatus (46); — M. Breweri (67).
Dale, H. — M. cardinalis (6); — M. moschatus (46).
Daniels, F. *25* M. guttatus var. Hallii (14c); *247* M. floribundus (44).
Darnell, H. H. *49* M. alatus (2).
Davidson, A. *1108, 2697* M. Bigelovii (74); *1975* M. discolor (64); *3279* M. subsecundus var. constrictus (78b); — M. Parishii (51).
Davidson, C. — M. ringens (1); — M. alsinoides (48).
Davis, H. — M. aurantiacus (112).
Davis, J. —, *129* M. ringens (1); *3342* M. alatus (2).
Davy, J. B. *196* M. aurantiacus (112); *438* M. Douglasii (103); *933* M. latidens (31); — M. Dudleyi (50).
Day, M. A. *9* M. ringens (1).
Dawson, — M. floribundus (44).
Deam, C. C. *58* M. ringens (1); *133, 1577* M. alatus (2).
Dewart, F. W. *7, 26* M. alatus (2).
Dice, L. R. — M. aurantiacus (112).
Dickson, J. H. *6396* M. guttatus var. decorus (14c).
Dix, — M mephiticus (88).
Douglas, D. — M. cardinalis (6); — M. guttatus (14); — M. floribundus (44); — M. moschatus (46); — M. Lewisii (52); — M. Douglasii (103); — M. longiflorus var. linearis (108e).
Douglas, E. — M. alatus (2).
Dows, B. — M. cardinalis (6).
Dregè, J. — M. gracilis (3).
Drew, E. R. — M. floribundus (44); — M. moschatus var. sessilifolius (46b); — M. Layneae (82).
Drushel, J. A. *888* M. ringens (1); — M. guttatus (14); — M. brevipes (70); — M. longiflorus (108); — M. puniceus (113).
Dudgeon, W., & Kenoyer, L. A. *141* M. gracilis (3).
Dudley, W. R. *430, 3340* M. cardinalis (6); — M. subsecundus (78), *566* var. constrictus (78b); *590* M. mephiticus (88); *605, 1887, 2437, 2942, 3087, 3168* M. primuloides (54), var. linearifolius (54a); — M. longiflorus (108), —, *750* var. calycinus (108a); *687, 921,* — M. moschatus var. longiflorus (46a), — var. sessilifolius (46b); *1369, 3997* M. Bolanderi (71); *1381* M. bicolor (55); *1382* M. acutidens (32); *1430,* —, *1553,* — M. Lewisii (52); *1607* M. Tilingi (13); *1663* M. leptaleus (91); —, *1717* M. leptaleus (91); *1799,* — M. Grayi (33); 2319 M. nasutus (17); *2364,* — M. Breweri (67); *2488, 2498* M. stamineus (90); *3009* M. guttatus (14); — M. dentatus (38); — M. Pulsiferae (40); — M. Dudleyii (50); — M. Palmeri (57); — M. Fremontii (77); — M. Torreyi (81); — M. coccineus (89); — M. modestus (101); — M. Kelloggii (102); — M. leptanthus (109).
Dudley, W. R., & Lamb, F. H. *4359, 4504* M. Bigelovii (74).
Dunn, G. W. — M. brevipes (70).
Dwyer, Bishop — M. gracilis (3).
Earle, F. S. — M. longiflorus (108).
Eastwood, A. *6, 66, 185, 433, 1676, 4455, 4737* M. aurantiacus (112); *19, 461, 543, 4960, 5051, 6388* M. longiflorus (108); *1738a* M. Bigelovii (74); *4613, 6835* M. Kelloggii (102); *6397* M. parviflorus (114); *6502* M. puniceus (113); — M. latidens (31); — M. tricolor (98), — M. modestus (101); — M. leptanthus (109), *4542* M. Rattani (80).

Eby, A. F. — M. ringens (1); — M. alatus (2).
Eby, J. H. — M. ringens (1).
Ecklon, C. F. — M. gracilis (3).
Edwards, Helen, — M. cardinalis (6); — M. nasutus (17); — M. bicolor (55); — M. Torreyi (81); — M. Kelloggii (102); — M. leptanthus (109).
Edwards, H. *505* M. Lewisii (52).
Eisen, G. — M. acutidens (32).
Eisenhower, C. W. — M. ringens (1); — M. alatus (2).
Eliot, H. — M. cardinalis (6); — M. guttatus (14); — M. longiflorus var. calycinus (108a).
Ellis, C. C. *294* M. glabratus var. Fremontii (25a).
Elmer, A. D. E. *164*, *2583*, *3645*, *4857* M. guttatus (14); *642*, *1280* M. Tilingi var. caespitosus (13a); *646*, *2572* M. Lewisii (52); *745* M. moschatus (46), *8074* var. longiflorus (46a), *2589* var. sessilifolius (46b); *752* M. ampliatus (42); *754*, *3354* M. floribundus (44); *774* M. breviflorus (30); *777* M. nasutus (17); *3356* M. Bolanderi (71); *3359*, *4056*, *4941* M. cardinalis (6); *3367* M. leptanthus (109); *3371* M. subsecundus (78); *3821* M. nasutus (17); *3859* M. primuloides (54); *3933* M. brevipes (70); *3959* M. longiflorus (108); *4355*, *4377* M. aurantiacus (112); *4519* M. decurtatus (79); *5049* M. Douglasii (103).
Elmer, O. — M. tricolor (98).
Elrod, M. J. — M. guttatus (14); — M. Lewisii (52).
Emig, W. H. *19*, *69*, *176*, *235* M. alatus (2).
Engelmann, G. — M. ringens (1); — M. Tilingi (13); — M. guttatus (14); — M. floribundus var. membranaceus (44b); — M. moschatus (46); — M. primuloides (54); — M. Layneae (82).
Engelmann, H. — M. glabratus var. Fremontii (25a); — M. guttatus (14).
Epling, C. *5378* M. moschatus (46); *5549*, *5554* M. dentatus (38); *5551* M. guttatus var. depauperatus (14b); *5555* M. Tilingi (13).
Essig, E. O. — M. guttatus (14); — M. Lewisii (52).
Evans, H. M. — M. Lewisii (52); — M. primuloides (54).
Evans, J., & Hammond, H. S. — M. Suksdorfii (68).
Evans, W. H. — M. moschatus var. longiflorus (46a); — M. Cusickii (76); — M. Torreyi (81).
Evermann, B. W. — M. guttatus (14); — M. Lewisii (52).
Faurie, Père, *327* M. sessilifolius (37).
Fendler, A. *558* M. guttatus (14); *559* M. glabratus var. Fremontii (25a).
Fenn, — M. pictus (105).
Fernald, M. L. *364* M. ringens (1).
Ferris, R. S. *699* M. guttatus (14); *758*, *1491*, *1550* M. Douglasii (103); *1204* M. glabratus var. Fremontii (25a); *1458* M. moschatus var. longiflorus (46a); *1459* M. Lewisii (52); *1464* M. stamineus (90); *1490* M. bicolor (55); *1602*, *1626* M. nasutus (17); *1729* M. Fremontii (77).
Ferris, R. S., & Duthie, R. *560* M. Cusickii (76).
Fiebrig, K. *2077* M. glabratus (25).
Fieldstad, F. L. — M. ringens (1).
Fischer, W. *266* M. pilosiusculus (24).
Fitzpatrick, T. J., & Fitzpatrick, M. F. L. — M. ringens (1).
Fletcher, J. — M. Tilingi var. caespitosus (13a).
Flett, J. B. *34*, *161* M. guttatus (14), *9* var. decorus (14d); *130* M. moschatus var. sessilifolius (46b); *168* M. Tilingi var. caespitosus (13a).
Fowler, J. — M. ringens (1).
Freiberg, G. W. — M. guttatus (14); — M. moschatus var. sessilifolius (46b).
Fremont, *201* M. Kelloggii (102); *509* M. aurantiacus (112); *510* M. leptanthus (109); — M. Fremontii (77).
French, C., Jr. — M. gracilis (3); — M. prostratus (28).
Fritchey, J. Q. A. *1* M. Bolanderi var. brachydontus (71a); *3* M. Grayi (33); *6* M. longiflorus (108); *9* M. subse-

cundus var. viscidus (78a); *10* M. modestus (101); *25, 86* M. moschatus var. longiflorus (46a); *39* M. guttatus (14); *69* M. Torreyi (81); — M. alatus (2); — M. brevipes (70); — M. puniceus (113).

Funston, F. *55* M. guttatus (14).

Gammie, G. A. — M. nepalensis var. procerus (35b).

Gardner, N. L. *513, 567* M. guttatus (14); *531* M. cardinalis (6); *536* M. primuloides (54).

Garrett, A. O. *1645* M. Lewisii (52); *1802* M. guttatus (14).

Gates, F. G., & Gates, M. T. *10618* M. glabratus var. Fremontii (25a); *10660* M. ringens (1).

Gay, C. — M. cupreus (11); — M. glabratus var. parviflorus (25b).

Geldern, von C. — M. leptanthus (109).

Getty, F. — M. Douglasii (103).

Geyer, C. A. *119* M. glabratus var. Fremontii (25a).

Ghiesbreght, A. *682* M. glabratus (25).

Gillies, — M. luteus var. alpinus (10e); — M. glabratus var. parviflorus (25b).

Glatfelter, N. M. *328* M. ringens (1).

Goetz, F. *2* M. modestus (101); *4* M. Palmeri (57); *4a* M. Douglasii (103); *5* M. guttatus (14).

Goldman, E. A. *1237* M. Tilingi var. corallinus (13b); *2548* M. spissus (73).

Goodding, L. N. *99* M. rubellus (69); *115, 305, 769, 946, 982, 1650, 1702, 2292, 2299* M. guttatus (14); *130* M, glabratus var. Fremontii (25a); *135. 739* M. verbenaceus (8); *1956* M. Lewisii (52); — M. primuloides (54).

Grant, A. L. *1* M. inconspicuus (34); *2, 3m, 942, 950, 958, 960, 1308* M. bicolor (55); *5, 948, 969, 1004, 1093, 1181, 1309b, 1309c, 1378* M. guttatus (14), *15m*, *803, 977, 1231* var. depauperatus (14b); *15* M. Kelloggii (102); *41, 955, 996, 1033, 1178, 1335* M. Breweri (67); *55, 892, 984, 1175, 1468, 1514a* M. moschatus var. longiflorus (46a); *279, 1079, 1309a, 1311* M. leptaleus (91); *291, 1074, 1177, 1341, 1452, 1511, 1512a, 1563* M. primuloides (54); *320, 423, 1513, 1579* M. Tilingi (13), *112, 136, 971, 1081, 1294, 1342, 1411, 1551, 1614a* var. corallinus (13b); *357* M. stamineus (90); *647* M. tricolor (98); *766, 954, 957, 976, 1232* M. pulchellus (100); *781* M. subsecundus var. viscidus (78a); *807, 967, 995* M. Bioletti (56); *809* M. Bolanderi (71), *1005, 1065, 1264* var. brachydontus (71a); *823, 1344, 1469* M. floribundus (44), *44, 805, 970* var. subulatus (44c); *850, 963, 969*, —, *1300* M. Torreyi (81); *949, 1006, 1133, 1266* M. nasutus (17); *951, 983, 997, 1002, 1622* M. laciniatus (18); *956, 1270, 1298a* M. mephiticus (88); *968, 1041, 1200, 1296, 1310, 1356, 1458, 1494* M. Layneae (42); *1032, 1119, 1309, 1336, 1344a, 1412* M. arenarius (43); *1080, 1024, 1421a, 1480* M. discolor (64); *1116, 1567* M. Lewisii (52); *1207* M. Douglasii (103); *1208* M. modestus (101); *1397, 1700, 1701* M. cardinalis (6); *1481* M. leptaleus (91); *1618* M. longiflorus, hybrid (108b), *1619* hybrid (108c), *1650* var. rutilus (108d); *1662a* M. leptaleus (91); *1696* M. parviflorus (114).

Grant, G. B. *285, 3753* M. puniceus (113); *286*, — M. longiflorus (108); *790, 4452, 4488, 6658* M. floribundus (44), *790a* var. membranaceus (44b); *1409, 6923* M. primuloides (54); *2345* M. Grayi (33); *2423, 6636*, M. brevipes (70); *4245* M. moschatus (46), *1930, 4242* var. longiflorus (46a); *4454* M. cardinalis (6); *6203* M. Fremontii (77); *6352* M. Tilingi var. corallinus (13b); *6688* M. Bigelovii (74); *6946* M. Breweri (67).

Grant, G. B., & Wheeler, W. *6135* M. guttatus (14); *6143* M. cardinalis (6).

Grant, J. M. — M. dentatus (38); — M. moschatus (46).

Gray, Asa, — M. glaucescens (15); — M. moschatus var. sessilifolius (46b); — M. bicolor (55); — M. Torreyi (81); — M. mephiticus (88); — M.

leptaleus (91); — M. tricolor (98); — M. longiflorus (108).

Greene, E. L. *10* M. tricolor (98); *224* M. floribundus (44); *734* M. alsinoides (48); *989*, — M. primuloides (54); — M. Tilingi (13), — var. caespitosus (13a), — var. corallinus (13b); — M. guttatus (14); — M. glaucescens (15); — M. nasutus (17); — M. moschatus var. longiflorus (46a); — M. Lewisii (52); — M. Breweri (67); — M. tricolor (98); — M. longiflorus (108); — M. stellatus (111); — M. aurantiacus (112); — M. parviflorus (114).

Greenman, J. M. *1528*, *2112* M. ringens (1).

Gregg, J. — M. glabratus (25), *195*, *331*, *716*, var. Fremontii (25a).

Gregory, Mrs. — M. purpureus (62).

Griffiths, D. *4182* M. guttatus (14); *4183* M. rubellus (69); *4815* M. verbenaceus (8); — M. glabratus var. Fremontii (25a).

Grinnell, J. *7* M. parviflorus (114); *8* M. cardinalis (6).

Grinnell, F., Jr. — M. cardinalis (6); — M. floribundus (44); — M. moschatus var. longiflorus (46a); — M. brevipes (70); — M. longiflorus (108).

Gross, C. A. *23* M. cardinalis (6); *79* M. aurantiacus (112); *106* M. angustatus (99).

Hall, E. *374* M. guttatus var. decorus (14d); *376* M. moschatus var. sessilifolius (46b).

Hall, E., & Harbour, J. P. *398* M. guttatus var. Hallii (14c); *399* M. glabratus var. Fremontii (25a).

Hall, H. M. *709*, *2403*, *7508* M. Tilingi var. corallinus (13b); *1292*, *1523*, *8555* M. moschatus var. longiflorus (46a); *1312*, *2349* M. primuloides (54); *1449* M. Palmeri (57); *1458* M. rubellus (69); *1543*, *2049*, *7791* M. Fremontii (77); *1959* M. diffusus (61); *2058* M. brevipes (70); *2202* M. floribundus (44); *2346*, *8704* M. Breweri (67); *2382* M. cardinalis (6); *3160*, *7739* M. longiflorus (108), *2928* hybrid (108b); *6011* M. Bigelovii (74); *7571* M. Parishii (51); *8897* M. pulchellus (100); *9055* M. mephiticus (88); *9056* M. Layneae (82); *9298* M. Torreyi (81); *9907* M. latidens (31).

Hall, H. M., & Babcock, E. B. *3532*, *3533* M. primuloides (54); *4154* M. Breweri (67); *5033* M. subsecundus var. viscidus (78a); *5405* M. mephiticus (88).

Hall, H. M., & Babcock, H. B. *5050* M. discolor (64); *5107*, *5113*, *5113b*, *5113c*, *5155* M. deflexus (66); *5218* M. stamineus (90); *5622* M. mephiticus (88).

Hall, H. M., & Chandler, H. P. *4* M. subsecundus var. viscidus (78a); *5* M floribundus var. geniculatus (44a); *21*. M. acutidens (32); *63* M. bicolor (55); *64*, *4782* M. Torreyi (81); *123* M. laciniatus (18); *169* M. primuloides (54); *208* M. Layneae (82); *212* M. moschatus var. longiflorus (46a); *321* M. Breweri (67); *339*, *5155b*, *5155c* M. discolor (64); *352* M. Lewisii (52); *377* M. Whitneyi (93); *429* M. leptaleus (91); *511* M. longiflorus var. calycinus (108a); *692* M. Tilingi var. corallinus (13b); *6790* M. Bigelovii (74); *6817* M. mohavensis (94).

Hall, H. M., & Hall, G. C. *8346* M. mephiticus (88).

Hammond, E. W. *310* M. cardinalis (6); *311* M. guttatus (14); *312* M. moschatus (46); — M. Douglasii (103).

Hannibal, E. — M. tricolor (98); — M. aurantiacus (112).

Hansen, G. *108* M. Douglasii (103); *109*, *1291* M. Kelloggii (102); *134* M. cardinalis (6); *135*, *473*, *1049*, *1288* M. nasutus (17); *441* M. Breweri (67); *462*, *471* M. Lewisii (52); *462* M. primuloides (54); *463* M. mephiticus (88); *466*, *1121*, *1122*, *1729* M. bicolor (55); *1050*, *1801*, *2053* M. guttatus (14), *1048*, *1287* var. arvensis (14e); *1051*, *1052* M. aurantiacus (112); *1124*, *1125* M. Torreyi (81); *1126*, *1290* M. inconspicuus (34);

1289 M. Tilingi (13); *1683* M. angustatus (99); *1809* M. Bolanderi (71); *1908* M. moschatus (46), *465*, *1951* var. longiflorus (46a).
Hanson, H. C. *590* M. glabratus var. Fremontii (25a).
Hardy, M. M. — M. leptanthus (109).
Harper, R. *342* M. ringens var. minthodes (1a).
Harris, J. A *C16295*, *C16440* M. cardinalis (6); *C16309* M. guttatus (14).
Hartman, C. V. — *288* M. dentilobus (21).
Hartweg, T. *1892* M. bicolor (55); — M. moschatus var. sessilifolius (46b); — M. tricolor (98).
Harvey, W. H. — M. repens (26).
Harwood, R. D. *4347* M. moschatus var. sessilifolius (46b); *4349* M. purpureus (62).
Harz, E. — M. guttatus (14).
Hasse, H. E. — M. alatus (2); — M. cardinalis (6); — M. nasutus (17);— M. floribundus (44); — M. moschatus var. longiflorus (46a), — var. sessilifolius (46b); — M. brevipes (70); — M. longiflorus (108).
Hasse, H. E., & Davidson, A. — M. floribundus var. geniculatus (44a).
Hastings, G. T. *423*, *523* M. luteus var. rivularis (10d).
Hawver, E. P. — M. aurantiacus (112).
Hayden, F. V. — M. guttatus (14); — M. glabratus var. Fremontii (25a); — M. nanus (83).
Heacock, E. R. *407* M. Tilingi var. caespitosus (13a).
Heerman, A. L. — M. Kelloggii (102).
Heller, A. A. *5923*, *13060* M. moschatus (46), *6947*, *6973*, *7960*, *11511*, *11714*, *12064*, *12165*, *12797*, *12875* var. longiflorus (46a), *12828* var. sessilifolius (46b); *5924*, *6829*, *7163*, *7433*, *7838*, *8027*, *8343*, *8376*, *8517*, *10420*, *10755*, *11200*, *11492*, *11868*, *12771*, *12813*, *13147*, *13191*, *13271*, *13284*, *13417* M. guttatus (14), *8323*, *13061* var. depauperatus (14b), *10569* var. Hallii (14e), *5687*, *7393*, *12299* var. arvensis (14e); *5927*, *6893*, *11495* M. Breweri (67); *6210*, *8212*, *10889* M. rubellus (69); *6580*, *7449*, *12305* M. aurantiacus (112); *6870*, *10799*, —, *11414*, *12271* M. Torreyi (81); *6972*, *9786*, *11497*, *13309* M. primuloides (54); *7067* M. leptaleus (91); *7137*, *9969*, *12918*, *13318* M. Tilingi (13), *7004*, *10922*, *12539* var. corallinus (13b); *7173* M. densus (87); *7141*, *9564*, *10203*, *12155*, *12620* M. Lewisii (52); *7272* M. Douglasii (103); *7508*, *7858*, *8158*, *8591*, *10192*, *11339* M. nasutus (17), *12344* var. insignis (17a), *7410*, *8936*, *13256* var. micranthus (17b); *7771* M. longiflorus var. calycinus (108a); *7961*, *11805*, *13261*, *13391* M. Pulsiferae (40); *7963*, *8194*, *11919* M. Layneae (82); *8142* M. floribundus var. membranaceus (44b); *8279*, *10890* M. Bigelovii (74), *8194* var. cuspidatus (74a); *9733* M. Suksdorfii (68); *10343* M. angustifolius (86); *10407* M. leptanthus (109); *11314* M. tricolor (98); *11338*, *11905* M. bicolor (55); *11340*, *11340a*, *13191* M. glaucescens (15); *11343* M. latidens (31); *11374* M. Kelloggii (103); *11806* M. angustatus (99); *11927*, *11992* M. Bolanderi var. brachydontus (71a); — M. Fremontii (77); *13142* M. nudatus (16.)
Heller, A. A., & E. G. *3143* M. nasutus (17); *3315* M. moschatus (46), *3961* var. sessilifolius (46b); *3320* M. breviflorus (30); *3324* M. nanus (83); *3330* M. ampliatus (42); *3926* M. dentatus (38); *3986*, —, *4006*, M. guttatus (14), *4006*, in part, var. decorus (14d).
Heller, A. A., & Brown, H. E. *5146*, *5282*, *5464* M. Kelloggii (102); *5258*, *5388* M. aurantiacus (112); *5306*, *5503* M. nasutus (17), *5349* var. insignis (17a); *5417*, *5554* M. tricolor (98); *5461* M. glaucescens (15); *5493* M. guttatus (14); *5331* var. arvensis (14e); *5545* M. bicolor (55).
Heller, A. A., & Halbach, E. G. *633* M. alatus (2).
Heller, A. A., & Kennedy, P. B. *8672*

M. densus (87); *8688* M. Suksdorfii (68); *8753* M. Breweri (67); *8783* M. primuloides (54); *8794* M. guttatus (14); *8819* M. Torreyi (81).

Henderson, L. F. *753* M. Douglasii (103); *754* M. Lewisii (52); *755* M. primuloides (54); *2264*, *4610* M. breviflorus (30); *2675*, *2675a*, *2676* M. ampliatus (42); — M. guttatus var. decorus (14d); — M. floribundus (44); — M. moschatus (46); — M. alsinoides (48).

Henry, A. *5897*, *7445*, *10450* M. nepalensis (35).

Henry, J. K. *9054* M. moschatus var. longiflorus (46a); — M. nasutus (17); — M. alsinoides (48).

Henshaw, H. W. *100* M. diffusus (61); — M. brevipes (70); — M. Fremontii (77).

Herbrand, M. — M. leptanthus (109).

Herrick, C. L. *33* M. glabratus var. Fremontii (25a).

Hiatt, O. — M. longiflorus (108).

Hieronymus, G., & Lorentz, P. G. *719* M. glabratus (25).

Hitchcock, A. E. *1256* M. rubellus (69).

Hitchcock, A. S. — M. ringens (1); — M. alatus (2); — M. glabratus var. Fremontii (25a).

Hitchcock, M. *24* M. cardinalis (6).

Hochstetter, *1629* M. gracilis (3).

Holzinger, J. M. — M. dentilobus (21).

Hooker, J. D. — M. repens (26); — M. nepalensis var. japonica (35a), var. procerus (35b).

Hopping, R. *111* M. Palmeri (57).

House, H. D. *4978* M. guttatus (14).

Howard, Mrs. C. W. *22* M. gracilis (3).

Howell, J. — M. stamineus (90).

Howell, T. *236* M. Pulsiferae (40); *382* M. cardinalis (6); *454*, — M. alsinoides (48); *517* M. floribundus (44); *519* M. washingtonensis (41); *1242*, *1246*, *1466* M. Douglasii (103); — *1243* M. primuloides (54); *1244* M. guttatus (14); *1454* M. aurantiacus (112); — M. dentatus (38); — M. Lewisii (52); — M. Cusickii (76); — M. nanus (85); — M. stamineus (90).

Hull, W. R. — M. guttatus (14).

Hutchings, J. M. — M. mephiticus (88).

Illin, N. *165* M. glabratus (25).

Ingalls, M. P. — M. aurantiacus (112).

Jackson, H. S., & Hammond, E. W. — M. nanus (83).

Jackson, H. S., & Standley, P. — M. Lewisii (52).

James, J. F. — M. alatus (2).

James, — M. glabratus var. Fremontii (25a).

Jenkins, & Street, L. *1938* M. brevipes (70); — M. nasutus (17); — M. floribundus (44).

Jepson, W. L. *2m*, *4m*, *14m*, *15m*, *21m*, *687*, *1198a*, *1812*, *2503*, *4043*, *4142*, *4812*, *5569*, *6326*, *7853*, *7955*, *8397*, *8833*, *8994*, M. guttatus (14), *12m*, *3482*, *4909*, *6429* var. depauperatus (14b), *1m*, *10m*, *11m*, *4628*, *6238*, *6238a*, *8370*, *9171*, *9285* var. arvensis (14e); *3m*, *6m*, *7m*, *19m*, *66m*, *4274a*, *9168*, *9169*, *9172*, *9173* M. nasutus (17), *8m* var. insignis (17a); *26m* M. cardinalis (6); *31m*, *32m*, *33m* M. latidens (31); *34m*, *35m*, *36m*, *71m*, *3037a*, *3142*, *4327*, *6169*, *6361*, *6888*, *9000* M. Layneae (82); *28m*, *63m*, *68m*, *6388*, *6398* M. Kelloggii (102); *37m* M. nanus (83); *38m*, *3143*, *3442*, *4627*, *6401* M. floribundus var. subulatus (44c); *52m*, *53m*, *3341*, *7266* M. primuloides (54); *54m*, *67m*, *740*, *775*, *2108*, *4273*, *5072* M. Breweri (67); *55m*, *57m*, *58m* M. Pulsiferae (40); *61m*, *6335* M. Douglasii (103); *62m*, *8252* M. tricolor (98); *69m*, *4070*, *4635*, *8396* M. Torreyi (81); *72m* M. Bioletti (56); *591*, *4321* M. Grayi (33); *593*, *4862*, *6741*, *8492* M. longiflorus, hybrid (108c), *8504* var. linearis (108e); *658*, *4274* M. laciniatus (18); *699*, *3214a*, *4674* M. mephiticus (88); *904*, *1020*, *3355*, *8091* M. Tilingi (13), *868* var. caespitosus (13a), *771*, *3406*, *4086*, *4334*, *4574* *4641*, *4692*, *4887a*, *5076*, *6479* var. corallinus (13e); *717*, *4310*, *6489b* M. discolor (64); *946*, *4957*, *5057*, *7304* M. stamineus (90); *979*, *2846*, *4688* M. coccineus (89); *1211*, *1518* *5552*, *6106*, *9133* M.

brevipes (70); *1402* M. Parishii (51); *1524* M. diffusus (61); *1573, 2680, 5581, 8681* (77); *1604a* M. puniceus (113); *1651* M. subsecundus (78), *65m, 566, 793, 1797, 2750, 4869, 7181* var. *viscidus* (78a); *1656, 2247, 6352* M. Bolanderi (71), *22m, 2751, 4314, 9054* var. brachydontus (71a); *1691, 4150* M. leptanthus (109); *1846,* — M. angustatus (99); *2797* M. acutidens (32); *3367, 4480, 8111, 8165* M. Lewisii (52); *4112* M. Jepsonii (92); *4272, 7855* M. moschatus (46), *42m, 44m, 45m, 46m, 51m, 680a, 2300, 3161a, 4429, 4640, 4883, 4980, 8342, 9803* var. longiflorus (46a), *43m, 47m, 48m, 49m, 50m* var. sessilifolius (46b); *4968, 5058, 5068* M. deflexus (66); *5070, 7262* M. Suksdorfii (68); *5823* M. mohavensis (31); *5862, 5911, 6956, 8580, 8797, 8945* M. Bigelovii (74), *6888* var. cuspidatus (74a); *6341, 6371* M. inconspicuus (34); *7305* M. densus (87).

Jepson, W. L., & Hall, H. M. *1293* M. Fremontii (77); *1959* M. diffusus (61).

Johnson, R. — M. tricolor (98).

Johnston, E. L. *120* M. glabratus var. Fremontii (25a); *351* M. floribundus var. membranaceus (44b).

Johnston, I. M. *1203,* — M. brevipes (70); *1204* M. guttatus (14); *1486, 1562* M. Johnstonii (75); *1524* M. cardinalis (6); —, *1607* M. longiflorus (108), *2286, 2288, 2295* hybrid (108b), *2280 2281, 2283, 2284, 2289, 2292, 2293, 2297* hybrid (108c), *2282, 2285, 2290, 2291, 2294, 2296* var. linearis (108e); *2307* M. nasutus (17); *2312* M. Fremontii (77); *2900* M. Breweri (67); *4113* M. dentilobus (21); *5590* M. Bigelovii (74); — M. floribundus, (44); — M. primuloides (54); *2284, 2298* M. puniceus (113).

Jones, M. E. *212* M. glabratus var. Fremontii (25a); *1655* M. Parryi (72); *2396* M. leptaleus (91); *2459* M. Jepsonii (92); *3188,* — M. Fremontii (77); *3288* M. leptanthus (109); *3439* M. puniceus (113); —, *3860* M. Bigelovii (74), *5054* var. cuspidatus (74a); *5272* M. guttatus (14); *5349* M. Eastwoodiae (53); *6486* M. Lewisii (52); — M. Tilingi (13); — M. moschatus var. longiflorus (46a); — M. primuloides (54); — M. Suksdorfii (68); — M. Torreyi (81).

Jorgensen, P. *980* M. glabratus (25); *1268* M. luteus var. alpinus (10e).

Kellerman, W. A. — M. glabratus var. Fremontii (25a).

Kelley, H. — M. Palmeri (57).

Kellogg, A., & Branner, J. M. — M. moschatus var. longiflorus (46a).

Kellogg, A., & Harford, W. G. W. *683* M. alsinoides (48).

Kellogg, J. H. *133* M. alatus (2).

Kennedy, P. B. *190, 269* M. Lewisii (52); *577* M. guttatus (14), *4356* var. Hallii (14c); *598* M. nanus (83); *1487* M. Bigelovii var. cuspidatus (74a); *1886* M. Tilingi var. corallinus (13b); *4091, 4401* M. densus (87).

Kennedy, P. B., & Doten, S. B. *106* M. nasutus (17); *118* M. guttatus var. depauperatus (14b); *121* M. Breweri (67).

King, M. A. — M. cardinalis (6); — M. brevipes (70).

Kirk, T. *124,* — M. repens (26).

Kirkwood, J. E. *28, 29* M. Lewisii (52); *51* M. Tilingi (13).

Kitts, C. W. — M. leptanthus (109).

Kofoid, C. A. — M. glabratus var. Fremontii (25a).

Komarov, V. — M. nepalensis (35).

Kuntze, O. — M. gracilis (3); — M. luteus var. rivularis (10a).

Lake, & Hull, W. R. — M. guttatus (14); — M. Lewisii (52).

Lamb, F. H. *1065* M. guttatus (14).

Langille, H. D. — M. Lewisii (52).

Lathrop, L. — M. Lewisii (52); — M. tricolor (98); — M. Douglasii (103).

Laybourn, W. A. *16* M. glabratus var. Fremontii (25a).

Leiberg, J. B. *348, 2018, 2076* M. Suksdorfii (68); *383, 1168* M. moschatus (46); *491, 1167* M. Pulsiferae (40); *1071, 1519* M. guttatus (14);

1365 M. Breweri (67); *1394, 1446* M. Tilingi (13); *1424* M. Lewisii (52); *5171* M. Leibergii (47).
Lemmon, J. G. *72* M. moschatus var. longiflorus (46a); *1129½* M. bicolor (55); *3270* M. Suksdorfii (68); — M. cardinalis (6); — M. floribundus (44); — M. Lewisii (52); — M. Bolanderi var. brachydontus (71a); — M. Fremontii (77); — M. mohavensis (94); — M. Jepsonii (92).
Letterman, G. W. *80* M. Lewisii (52); *116*, — M. nanus (83); — M. moschatus (46); — M. guttatus (14).
Lister, — M. nepalensis var. japonica (35a).
Lindheimer, F. *717* M. glabratus (25).
Lloyd, C. E. *438* M. glabratus (25); *440* M. dentatus (21).
Lloyd, F. E. — M. dentatus (38).
Lucy, T. F. *154* M. ringens (1).
Lunnell, J. — M. guttatus var. decorus (14d); — M. moschatus (46); — M. alsinoides (48).
Lyall, T. — M. madagascariensis (4); — M. alsinoides var. minimus (48a).
Lyon, M. W., Jr. *58* M. moschatus (46); *59* M. guttatus var. decorus (14d).
Macbride, J. F. *59, 402* M. nanus (83); *170* M. nasutus (17); *261, 421, 569* M. moschatus (46); *403, 808, 2541* M. guttatus (14), *143* var. depauperatus (14b); *404* M. Breweri (67); *414, 571* M. Lewisii (52); *665* M. primuloides (54); *775* M. Suksdorfii (68); *900* M. breviflorus (30).
Macbride, J. F., & Payson, E. B. *750* M. cardinalis (6); *759* M. brevipes (70); *765* M. floribundus (44); *2930, 3049* M. nanus (83); *3093* M. breviflorus (30); *3419, 3752* M. Tilingi var. caespitosus (13a); *3627* M. primuloides (54); *3703* M. Breweri (67); *3731* M. Lewisii (52).
McCalla, W. C. *457* M. ringens (1).
McCallum, Mrs. A. — M. aurantiacus (112).
McClatchie, A. J. *96* M. diffusus (61).
McCormick, P. — M. cardinalis (6).
MacDaniels, L. H. *137* M. ringens (1).
McDonald, F. E. — M. ringens (1).
MacDougal, D. T. *15* M. rubellus (69); *244* M. guttatus (14); — M. verbenaceus (8); — M. leptanthus (109).
McGregor, E. A. *32* M. floribundus (44); *40* M. Lewisii (52); *66* M. aurantiacus (112); *105* M. brevipes (70); 191 M. leptaleus (91); *223* M. alatus (2); *837* M. Bigelovii (74); *954* M. Fremontii (77).
MacKay, E. *11, 17* M. guttatus (14).
MacKenzie, K. K. *289, 292, 295* M. alatus (2); *352* M. guttatus (14); *2837* M. ringens (1).
McMurphy, J. *25, 294* M. aurantiacus (112); *295* M. cardinalis (6); *297* M. moschatus var. sessilifolius (46b); — M. Layneae (82).
Macoun, J. M. *702, 54480, 87665* M. guttatus (14); *703, 54483 87669* M. alsinoides (48); *54485, 76792* M. Lewisii (52); *67855* M. Breweri (67); — M. Tilingi (13), *76795, 76796* var. caespitosus (13a); *76789* M. moschatus (46), —, *54474*, var. longiflorus (46a), *87657* var. sessilifolius (46b); *80935* M. ringens (1); *87662* M. nasutus (17); — M. floribundus (44).
Maiden, J. H. — M. prostratus (28).
Mains, G. B. *D-70* M. Lewisii (52).
Marsh, C. D. *14165* M. Lewisii (52).
Matsumura, J. — M. nepalensis (35).
Mathews, W. C. *30* M. aurantiacus (112); *135* M. moschatus var. sessilifolius (46b); *177* M. cardinalis (6).
Mearns, E. A. *3507* M. brevipes (70); *3659* M. longiflorus var. linearis (108e); *3948, 4030* M. cardinalis (6).
Meehan, T. — M. guttatus (14); — M. laciniatus (18); — M. Lewisii (52); — M. bicolor (55); — M. subsecundus (78).
Mell, C. D. — M. ringens (1).
Mell, C. D., & Knopf, — M. glabratus var. Fremontii (25a); — M. floribundus var. geniculatus (44a).
Merrill, E. D., & Wilcox, E. N. *819* M. guttatus (14); *827* M. floribundus var. membranaceus (44b); *971, 1072* M. Lewisii (52).

Mertens, Dr. — M. glabratus var. parviflorus (25b).
Metcalfe, O. B. *28, 208* M. glabratus var. Fremontii (25a); *28*, in part, *1537* M. guttatus (14); *1536* M. rubellus (69).
Michener, & Bioletti, F. — M. cardinalis (6); — M. nasutus (17), — var. insignis (17a); — M. moschatus var. longiflorus (46a).
Miles, L. O. *206* M. Lewisii (52).
Miller, Mrs. C. E. — M. longiflorus (108); — M. parviflorus (114).
Miller, Mrs. C. E., & Grant, Mrs. A. L. *1703, 1704* M. parviflorus (114).
Mizo-hoduki, — M. nepalensis var. japonica (35a).
Moffatt, W. S. *1652* M. ringens (1).
Monks, S. P. *6* M. cardinalis (6).
Moore, Mrs. S. H. — M. guttatus (14).
Morong, T. *66* M. ringens (1); *1213* M. glabratus var. parviflorus (25b).
Moseley, E. L. — M. ringens (1); — M. alatus (2).
Moxley, G. *582* M. subsecundus var. constrictus (78b).
Mueller, F. von — M. gracilis (3); — M. repens (26); — M. prostratus (28); — M. pusillus (29).
Muenscher, W. L. C. *375, 5070* M. guttatus (14); *964* M. moschatus (46); *965* M. Lewisii (52).
Mulford, I. *353*, — M. guttatus (14); *1152* M. glabratus var. Fremontii (25a); — M. moschatus (46); — M. Lewisii (52); — M. nanus (83); — M. tricolor (98).
Munson & Hopkins, — M. cardinalis (6).
Munz, P. A. *137* M. glabratus var. Fremontii (25a); *328* M. ringens (1); *1145, 1219, 2266, 3100, 3159* M. guttatus (14); *1207* M. cardinalis (6); *2033* M. longiflorus (108), *3362* var. rutilus (108d); *2145* M. puniceus (113); *2780* M. nasutus (17); *3028* M. Tilingi (13); *3613* M. Bigelovii (74); *4615* M. moschatus var. sessilifolius (46b); *5135* M. diffusus (61); *5651* M. purpureus (62); *5657, 5995* M. Suksdorfii (68); *5911* M. rubellus (69); *6707* M. puniceus (113); *7005* M. Fremontii (77); *7027* M. primuloides (54); *7062* M. Clevelandii (107).
Munz, P. A., & Harwood, R. D. *4010* M. longiflorus (108), *3356, 3339* hybrid (108c); *3758, 3853, 3854* M. puniceus (113); *4006* M. brevipes (70).
Munz, P. A., & Johnston, I. M. *2850* M. Breweri (67); *2856* M. Palmeri (55); *2858* M. moschatus var. longiflorus (46a); *5202, 5215* M. Parishii (51); *5217* M. rubellus (69); *5378* M. latidens (31); *5467* M. diffusus (61).
Munz, P. A., Johnston, I. M., & Harwood, R. D. *4031*, in part, *4514* M. guttatus (14); *4031*, in part, M. nasutus (17).
Munz, P. A., Street, L., & Williams, R. G. *2447* M. longiflorus, hybrid (108b).
Munz, P. A., Williams, R. G., & Corwin, G. *2916* M. Lewisii (52).
Najarre, P. — M. glabratus var. parviflorus (25b).
Nelson, A. *543, 8344, 9545* M. glabratus var. Fremontii (25a); *688*, in part, *1670, 2372, 3573, 9394* M. guttatus (14); *688*, in part, M. Tilingi var. corallinus (13b); *1287* M. Suksdorfii (68); *1672, 3531, 6276, 8523* M. Lewisii (52); *7440, 9076* M. floribundus (44), *1515, 1683, 7729, 8828, 8951* var. membranaceus (44b).
Nelson, A., & Macbride, J. F. *1032* M. Cusickii (76); *1227* M. nanus (83); *1278, 1344, 1842* M. guttatus (14), *1908* var. Hallii (14c); *1959* M. nasutus var. micranthus (17b); *2235* M. floribundus var. geniculatus (44a).
Nelson, A., & Nelson, E. *5494, 6256* M. nanus (83); *5748, 5841* M. guttatus (14), *6285* var. depauperatus (14a); *6371* M. Breweri (67).
Nelson, E. W. *797* M. nanus (83); *4775* M. Nelsonii (9); *6027* M. guttatus (14).
Nelson, J. C. *120* M. dentatus (38); *202* M. moschatus var. sessilifolius (46b); *1136* M. alsinoides (48).
Nevin, J. C. — M. Parishii (51).
Newberry, J. S. — M. Torreyi (81).

— M. Layneae (82); — M. Douglasii (103); — M. puniceus (113).
Parry, C. C., & Lemmon, J. G. *308* M. Palmeri (55); *309* M. Fremontii (77); *310* M. brevipes (70); *311* M. longiflorus (108); *312* M. Breweri (67).
Patterson, H. N. *251* M. floribundus var. membranaceus (44b); *294* M. guttatus var. Hallii (14c).
Patterson, H. N., & Wiltz. — M. floribundus (44); — M. aurantiacus (112).
Patzky. — M. verbenaceus (8).
Paulson, M. — M. aurantiacus (112).
Payson, E. B. *16, 110* M. guttatus (14); *331* M. rubellus (69).
Payson, E. B., & Payson, L. B. *1754* M. nasutus (17); *1755, 2226* M. floribundus (44); *1791, 2018* M. guttatus (14).
Peck, M. E. *5623* M. alsinoides (48); *7935* M. Pulsiferae (40); *8625* M. guttatus (14), *5606* var. depauperatus (14b); *8786* M. aurantiacus (112); *8810* M. dentatus (38); *9577, 9628* M. nanus (83); *9580* M. primuloides (54).
Peckinpah, Mrs. R. — M. floribundus var. geniculatus (44a).
Pennell, F. W. *2194, 2279, 2533* M. glabratus (25), *10444* var. Fremontii (25a).
Perry, R. C. — M. ringens (1).
Pierson, F. W. *195* M. brevipes (70); *197* M. nasutus (17); *198* M. guttatus (14); *199* M. Parishii (51); — M. diffusus (61).
Pilsby, H. A. — M. verbenaceus (8).
Pinco, A. J. — M. alsinoides (48).
Piper, C. V. *1657* M. clivicola (85); *1826, 1858* M. breviflorus (30); *1867* M. floribundus (44); *2783* M. nasutus (17); — M. guttatus (14).
Plaskett, R. A. *76* M. Douglasii (103); *122* M. leptanthus (109).
Platt, R. H. — M. Torreyi (81).
Pollard, C. L. *1323* M. alatus (2).
Pollock, W. M. — M. ringens (1); — M. alatus (2).
Pond, R. H. *1082* M. ringens (1), — var. minthodes (1a).
Prain, *71* M. gracilis (3).
Price, S. — M. alatus (2).
Price, W. W. — M. cardinalis (6); — M. glabratus var. Fremontii (25a); — M. moschatus var. longiflorus (46a); — M. Lewisii (52).
Pringle, C. G. *889* M. guttatus (14); *1347*, — M. nasutus (17); *3348* M. rupestris (7); *13149* M. glabratus (25); — M. rubellus (69); — M. brevipes (70).
Purpus, C. A. *327* M. glabratus (25), *2805* var. Fremontii (25a); *1372* M. deflexus (66); *1383, 1389* M. mephiticus (88); *5011* M. modestus (101); *5048* M. Palmeri (57); *5070, 5305* M. subsecundus var. constrictus (78b); *5243* M. Tilingi (13); *5311* M. discolor (64); *5338, 5621* M. longiflorus var. calycinus (108a); *5348, 5348a, 5786* M. Layneae (82); *5602* M. floribundus (44); *5619* M. moschatus var. longiflorus (46a); *5786, 6304, 6304a* M. Bigelovii var. cuspidatus (74a); *7015* M. pachystylus (49); *7069* M. rubellus (69).
Raber, H. — M. tricolor (98).
Ramaley, F. *115* M. guttatus var. puberulus (14a), *707* var. Hallii (14c).
Randall, A. *50* M. aurantiacus (112).
Rattan, V. — M. dentatus (38); *217* M. inconspicuus (34); — M. cardinalis (6); — M. Pulsiferae (40); — M. floribundus (44); — M. moschatus var. sessilifolius (46b); — M. alsinoides (48); — M. Lewisii (52); — M. bicolor (55); — M. Bolanderi (71), — var. brachydontus (71a); — M. subsecundus var. viscidus (78a); — M. Rattani (80); — M. Torreyi (81); — M. Layneae (82); — M. tricolor (98); — M. angustatus (99); — M. Kelloggii (102); — M. Douglasii (103); — M. aurantiacus (112).
Raw, E. A. *47* M. alatus (2).
Redfield, J. R. *240* M. guttatus (14); *247* M. Torreyi (81); *6093* M. aurantiacus (112); *6103* M. cardinalis (6); *6107* M. floribundus (44); *6121, 6128* M. ringens (1); *6121a* M. moschatus (46).

Reid, — M. Bridgesii (39).
Reverchon, J. *1341* M. glabratus (25), — var. Fremontii (25a).
Reynolds, Mrs. L. R. — M. leptanthus (109).
Rhoads, — M. cardinalis (6).
Rich, W. H. — M. floribundus (44); — M. moschatus var. longiflorus (46a).
Riehl, N. *41* M. ringens (1).
Robbins, W. W. *1616* M. guttatus (14), *1599* var. Hallii (14c); *2138* M. floribundus var. membranaceus (44b).
Robinson, O. W. — M. longiflorus (108); — M. puniceus (113).
Robinson, O. W., & Crocker — M. longiflorus, hybrid (108b), — var. linearis (108e).
Rose, J. N. *13* M. guttatus (14).
Rose, J. P. *1310* M. Lewisii (52).
Rose, J. N., Standley, P. C., & Russell, P. G. *13074*, *13381* M. verbenaceus (8); *13395* M. floribundus (44).
Rosendahl, C. O. *895* M. moschatus (46), *895a* var. sessilifolius (46b); *1929* M. guttatus (14).
Rosendahl, C. O., & Brand, E. J. *6* M. guttatus (14).
Rothrock, J. T. *378* M. stamineus (90); *401* M. cardinalis (6).
Roush, L. *1*, *5* M. guttatus (14); *2*, *3* M. moschatus (46).
Royle, J. F. — M. nepalensis (35).
Rusby, H. H. *321* M. guttatus (14); *764* M. rubellus (69); — M. ringens (1); — M. dentatus (38).
Ruth, A. *106*, *569* M. ringens (1); *568* M. alatus (2).
Rydberg, P. A. *6177* M. guttatus (14).
Rydberg, P. A., & Bessey, E. A. *4942* M. moschatus (46); *4945* M. guttatus (14).
Rydberg, P. A., & Carlton, E. C. *6354* M. moschatus (46); *7269* M. floribundus var. membranaceus (44b); *7621* M. guttatus (14).
Rydberg, P. A., & Garrett, A. O. *9883* M. Eastwoodiae (53).
Rydberg, P. A., & Vreeland, F. K. *5658* M. guttatus (14); *5659* M. glabratus var. Fremontii (25a); *5660* M. rubellus (69).
Sampson, A. W., & Pearson, J. A. *132* M. Lewisii (52).
Sandberg, J. H. *376* M. glabratus var. Fremontii (25a).
Sandberg, J. H., & Leiberg, J. B. *110* M. nasutus (17); *115* M. breviflorus (30); *362* M. moschatus (46); *557*, — M. Lewisii (52); *618* M. guttatus (14).
Sandberg, J. H., MacDougal, D. T., & Heller, A. A. *347* M. breviflorus (30); *444* M. moschatus (46); *586* M. clivicola (85); *926* M. floribundus (44).
Savage, T. E., Cameron, J. E., & Lenacker, F. E. — M. moschatus var. sessilifolius (46b); — M. Lewisii (52).
Scherer, C. M. — M. tricolor (98).
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Schoenfeldt, F. *3347*, *3480* M. brevipes (70); *3416* M. Fremontii (77); *3762*, *3835* M. cardinalis (6).
Schomburgh, R. — M. repens (26).
Schoper, M. *17* M. guttatus var. depauperatus (14b).
Schrenk, H. von. — M. ringens (1); — M. guttatus var. depauperatus (14b).
Scovell, J. T., & Clark, H. W. *1193* M. ringens (1).
Scouler, J. *182* M. alsinoides (48a).
Scribner, F. L. *189* M. Lewisii (52).
Seymour, F. C. *25* M. ringens (1).
Sheldon, E. P. *8146*, *8580*, *10034*, *11196*, *13006* M. guttatus (14); *8242*, *8773*, *10880* M. moschatus (46); *8806* M. Lewisii (52); *11863* M. alsinoides (48); *12959* M. dentatus (38).
Shaw, C. H. *434*, *984* M. Lewisii (52); *567*, *778*, *857*, *1113* M. guttatus (14); *662*, *1119* M. moschatus (46); *1094* M. Tilingi var. caespitosus (13a).
Shockley, W. H. *50* M. Bigelovii var. cuspidatus (74a); *84*, *111* M. densus (87); *301a* M. stamineus (90); — M. verbenaceus (8).
Shufeldt, M. A. *116* M. madagascariensis (4).
Shull, G. H. *103* M. ringens (1); *206* M. alatus (2).

Siler, A. H. *70* M. rubellus (69).
Skeels, H. C. — M. glabratus var. Fremontii (25a).
Small, J. *103* M. ringens (1).
Smart, *203* M. floribundus (44).
Smiley, F. J. *669* M. Layneae (82).
Smith, C. L. *406a* M. glabratus (25).
Smith, C. O. *208* M. longiflorus var. linearis (108e).
Smith, E. C. — M. Tilingi var. caespitosus (13a); — M. moschatus var. sessilifolius (46b); — M. Lewisii (52).
Smith, H. H. *3791* M. dentatus (38).
Smith, J. D. *2127* M. glabratus (25).
Smith, L. E. *14, 116* M. Kelloggii (102).
Smith, L. S. *750* M. primuloides var. linearifolius (54a).
Smith, R. J. — M. Fremontii (77).
Snodgrass, R. E. — M. parviflorus (114).
Sonne, C. F. *14* M. angustifolius (85); *262*, — M. Lewisii (52); *263*, — M. nasutus (17); *266, 266a* M. Tilingi (13); *267* M. guttatus (14); *268* M. moschatus var. longiflorus (46a); *271* M. Torreyi (81); — M. Breweri (67).
Spencer, M. F. *103* M. brevipes (70); *362* M. diffusus (61); *1288* M. moschatus var. longiflorus (46a); *1617* M. puniceus (113); *1709* M. guttatus (14), *1671* var. depauperatus (14b); — M. Fremontii (77).
Spreadborough, W. B. — M. Tilingi var. caespitosus (13a); — M. guttatus (14).
Spruce, R. *5168* M. glabratus (25).
Standley, P. C. *4089* M. guttatus var. puberulus (14a).
Starz, E. — M. moschatus (46); — M. Lewisii (52).
Steele, E. S. — M. alatus (2).
Steinmetz, F. J. — M. cardinalis (6); — M. Lewisii (52); — M. nanus (83).
Stevens, G. W. *63* M. glabratus (25), *318, 330, 782, 3010* var. Fremontii (25a); *2003½* M. alatus (2).
Stillman, J. D. B. — M. grandiflorus (109).
Stinchfield, A. S. — M. cardinalis (6); — M. Layneae (82).
Stinchfield, R. *14, 417* M. cardinalis (6); *81* M. aurantiacus (112); *138* M. Bolanderi (71).
Stokes, S. G. — M. cardinalis (6); — M. guttatus (14); — M. floribundus (44); — M. moschatus (46), — var. longiflorus (46a); — M. Lewisii (52); — M. rubellus (69); — M. brevipes (70); — M. Fremontii (77).
Stone, R. — M. cardinalis (6).
Strachey, R., & Winterbottom, J. E. — M. gracilis (3).
Street, L. — M. brevipes (70); — M. puniceus (113).
Styles, Dr. — M. luteus (10).
Sturtevant, E. L. — M. ringens (1).
Suksdorf, W. N. *51, 204, 560* M. washingtonensis (41); *203, 485, 4472* M. breviflorus (30); *205, 2185*, — M. floribundus (44); *420, 687* M. alsinoides (48); *473, 474, 478, 2136* M. guttatus (14), *2321, 2773* var. depauperatus (14b), *2774* var. decorus (14d); *476, 480, 792, 5016* M. nasutus (17); *479*, — M. Tilingi var. caespitosus (13a), *470, 472* var. corallinus (13b); *486*, — M. Pulsiferae (40); *487, 893* M. Suksdorfii (68); *1470* M. jungermannioides (45); *2320*, — M. moschatus var. longiflorus (46a); *6673* M. dentatus (38); 5779 M. Lewisii (52); — M. Breweri (67).
Sullivan, C., & Gray, A. — M. laciniatus (18).
Thacher, O. *55* M. brevipes (70); *56* M. cardinalis (6).
Thompson, C. H. — M. guttatus (14); — M. floribundus (44); — M. moschatus var. sessilifolius (46b); — M. aurantiacus (112).
Thompson, H. T. *1001, 1002* M. aurantiacus (112).
Thompson, J. H. *26, 209* M. cardinalis (6); *116* M. aurantiacus (112); *140* M. alsinoides (48); *178* M. dentatus (38); — M. Torreyi (81).
Thompson, Rev. — M. Tilingi var. caespitosus (13a).
Thomson, T. — M. gracilis (3).
Thornber, J. J. *378* M. rubellus (69);

379 M. nasutus (17); — M. ringens (1).
Thurber, G. *136* M. rubellus (69).
Tidestrom, I. — M. aurantiacus (112).
Tilden, J. *726* M. repens (26).
Titus, A. — M. tricolor (98).
Tokubuchi, E. — M. nepalensis (35); — M. sessilifolius (37).
Torrey, J. *370* M. Torreyi (81); *372* M. Cusickii (76); *373* M. Breweri (67); *379* M. Suksdorfii (68).
Toumey, J. W. — M. verbenaceus (8).
Townsend, C. H. T., & Barber, C. M. *28* M. guttatus (14); *324* M. pallens (20).
Townsend, E. C. — M. ringens (1).
Tracy, J. P. *833* M. dentatus (38); *1636*, *1620* M. angustatus (99); *1544*, *3443*, *4320* M. Layneae (82); *1747* M. Bolanderi (71); *2634* M. alsinoides (48); *3688* M. nasutus var. micranthus (17b); *4208* M. Douglasii (103).
Tracy, S. M. *8711* M. alatus (2).
Tracy, S. M., & Earle, F. S. *220* M. glabratus (25).
Trask, B. *267*, — M. puniceus (113); *341*, — M. floribundus (44); *342*, *343* M. guttatus (14); — M. cardinalis (6); — M. Traskiae (104).
Trelease, W. *68* M. Treleasei (106); *507*, *514*, *515*, *516* M. alatus (2); — M. ringens (1); — M. Fremontii (77).
Trelease, W., & Saunders, D. *4893*, *4894*, *4895*, *4896*, *4897* M. guttatus (14); *4890* M. Suksdorfii (68).
Tufte, E. T. *227* M. glabratus var. Fremontii (25a).
Turesson, G. W. *27* M. guttatus (14), *26* var. depauperatus (14b); *28* M. moschatus (46).
Tweedy, F. *577* M. Suksdorfii (68); *875* M. rubellus (69); *3422*, *5739*, *5740* M. guttatus (14); *5202* M. floribundus (44), *3423* var. membranaceus (44b).
Umbach, L. M. *796* M. Lewisii (52).
Van Dyke, E. C. *27*, *146*, *245*, *321* M. guttatus (14).
Vasey, G. R. *396* M. floribundus (44); *468* M. diffusus (61).
Veatch, — M. stellatus (111).
Vesey, X. de. *65* M. cardinalis (6).
Vogel, J. — M. guttatus (14); — M. Lewisii (52).
Volz, — M. alatus (2).
Vorhies, C. T. *119* M. Eastwoodiae (53).
Vortriede, W. — M. subsecundus (78).
Wagner, W. W. *300* M. moschatus var. longiflorus (46a); — M. nanus (83).
Waldron, L. R. *142* M. Lewisii (52).
Walker, E. P. *118* M. glabratus var. Fremontii (25a).
Walker, E. P., & Mrs. *778*, *885*, *982* M. guttatus (14).
Walker, H. A. *383* M. guttatus (14), *347*, *440* var. arvensis (14c); *713* M. moschatus var. sessilifolius (46b); *808* M. floribundus (44).
Walter, C. — M. gracilis (3); — M. repens (26).
Ward, L. F. *90* M. guttatus (14).
Watson, S. *309*, *794*, — M. floribundus (44); *790* M. montioides (65); *797* M. rubellus (69); *797* (from Utah) M. Suksdorfii (68); — M. Lewisii (52).
Webber, H. J. — M. ringens (1); — M. glabratus var. Fremontii (25a).
Weniger, W. — M. tricolor (98).
Wheeler, H. N. *312*, *372* M. Tilingi (13); *313* M. guttatus var. Hallii (14c).
White, M. *81* M. glabratus var. Fremontii (25a).
White, P. J. *6*, *149* M. glabratus var. Fremontii (25a); *80* M. ringens (1).
Whited, H. N. *48* M. nanus (83); *1081* M. alatus (2).
Wiegand, K. M. — M. ringens (1).
Wiegand, M. C., & Upton, Geo. B. — M. verbenaceus (8).
Wilcox, T. E. *119* M. verbenaceus (8).
Wilkerson, E. *10* M. Lewisii (52).
Wilkinson, M. *1* M. longiflorus (108).
Williams, R. S. *343* M. floribundus var. membranaceus (44b); — M. moschatus (46); — M. Lewisii (52).
Williams, T. A. — M. ringens (1); — M. guttatus (14); — M. glabratus var. Fremontii (25a).
Willits, V. *201* M. guttatus (14); *364* M. Lewisii (52).

Wilson, E. H. *1302* M. nepalensis (35).
Wilson, N. C. — M. Cusickii (76).
Wislizenus, F. *265* M. ringens (1); *266* M. alatus (2); *561* M. glabratus var. Fremontii (25a); *761* M. guttatus (14); *1291*, in part, M. longiflorus (108); *1291* M. puniceus (113).
Wolfe, J. *311* M. floribundus (44); *313* M. guttatus (14).
Wood, C. B. — M. alsinoides var. minimus (48a).
Wood, J. M. *1506*, *9193* M. gracilis (3).
Woods, C. N. — M. guttatus (14)· *42a* M. nanus (83).
Woods, F. F. — M. ringens (1).
Woolls, — M. gracilis (3).
Wooton, E. O. *28*, in part, M. nasutus (17); — M. guttatus (14); — M. rubellus (69).
Wright, C. *1482*, — M. glabratus (25); *1483* M. rubellus (69).
Zeller, S. M. — M. guttatus (14); — M. moschatus var. sessilifolius (46b).
Zeller, S. M., & F. B. *946* M. guttatus (14), *947* var. depauperatus (14b); *12021* M. moschatus (46).
Zundel, G. L. *192* M. guttatus (14).

Index to Species

New subgenera, sections, species, varieties, combinations, and new names are printed in **bold face** type; synonyms in *italics*, and previously published names in ordinary type.

Explanation of Plate

PLATE 3

Fig. 1. *Mimulus Treleasei* Grant.

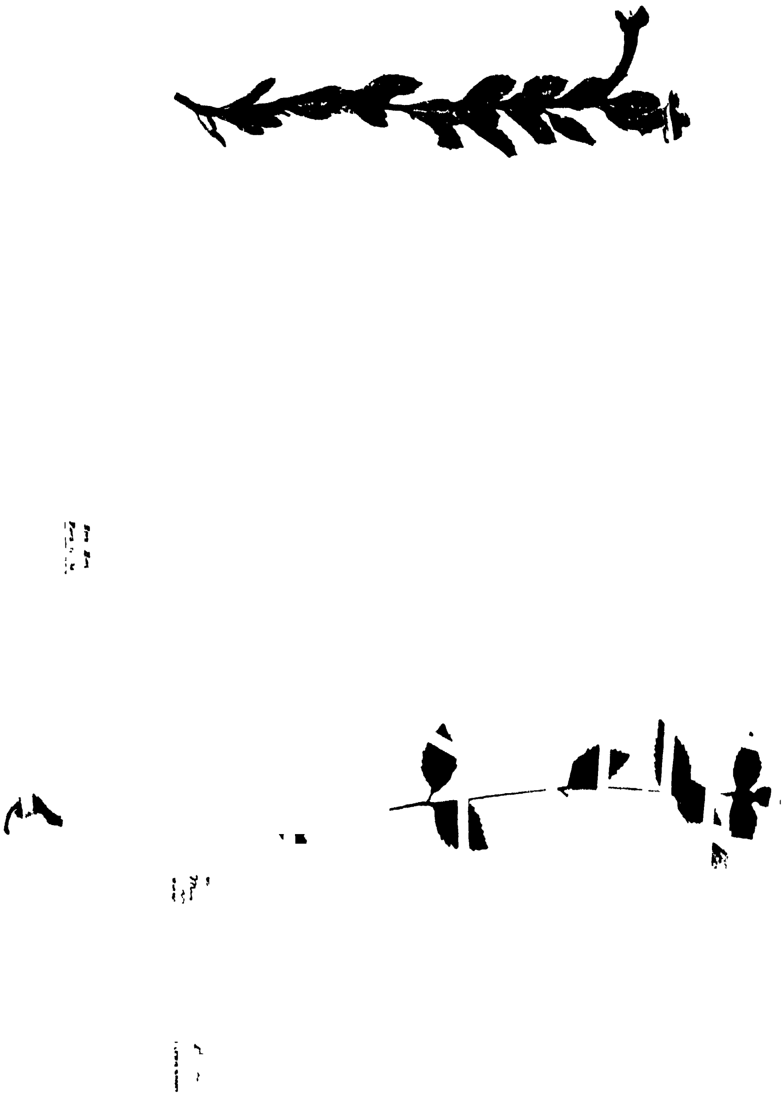
Mexico.

From the type specimen, Trelease No. 68, in the Herbarium of the Missouri Botanical Garden.

Fig. 2. *Mimulus nepalensis* Benth. var. *procerus* Grant.

India.

From the type specimen, Gammie, in the Herbarium of the Missouri Botanical Garden.



Explanation of Plate

PLATE 4

Fig. 1. *Mimulus guttatus* DC. var. *decorus* Grant.

California.

From the type specimen, Lyon No. 59, in the Herbarium of the Missouri Botanical Garden.

Fig. 2. *Mimulus Dudleyi* Grant.

California.

From the type specimen, Dudley, in the Herbarium at Stanford University.

GRANT—A MONOGRAPH OF THE GENUS MIMULUS

EXPLANATION OF PLATE

PLATE 5

Fig. 1. *Mimulus diffusus* Grant.

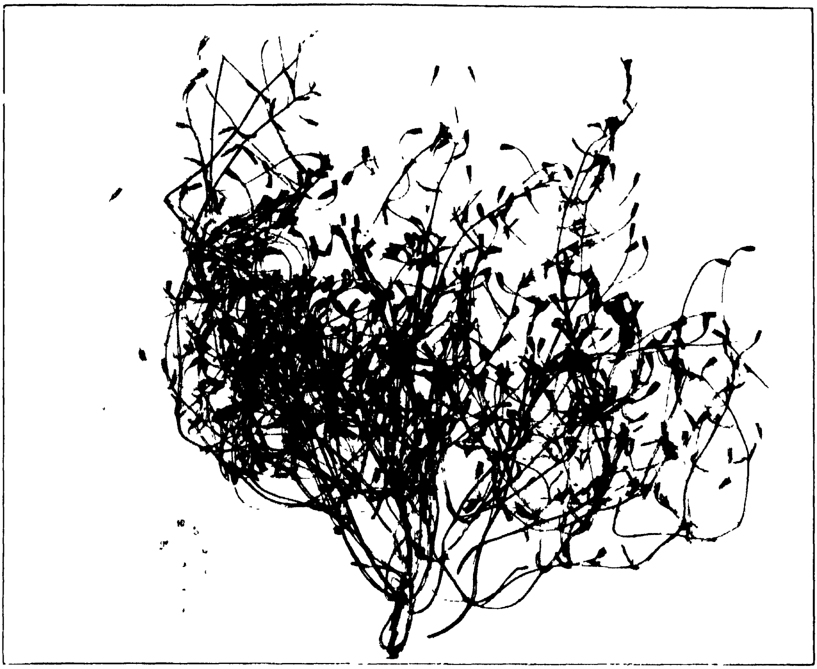
Oregon.

From the type specimen, Jepson & Hall No. 1959, in the Herbarium of the Missouri Botanical Garden.

Fig. 2. *Mimulus purpureus* Grant.

California.

From the type specimen, Parish & Parish No. 1862, in the Herbarium at Stanford University.



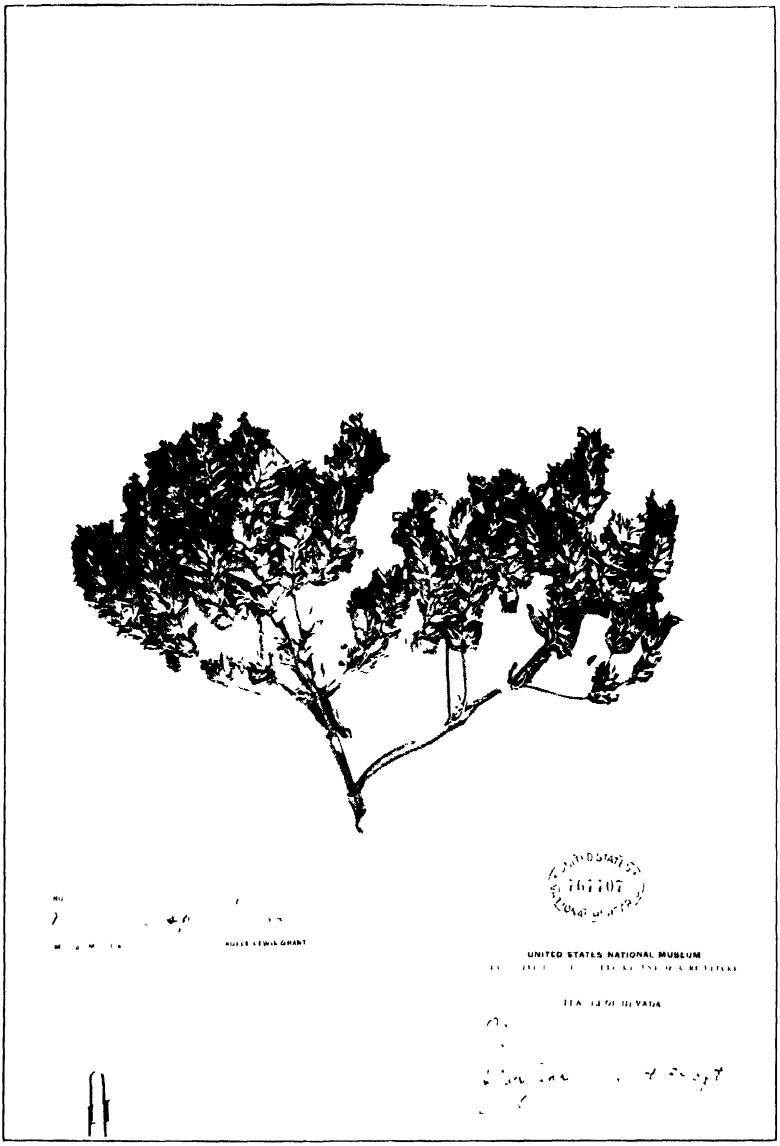
Explanation of Plate

PLATE 7

Mimulus spissus Grant.

Nevada.

From the type specimen, Goldman No. 2548, in the United States National Herbarium.



GRANT A MONOGRAPH OF THE GENUS MIMULUS

EXPLANATION OF PLATE

PLATE 8

Fig. 1. *Mimulus arenarius* Grant; habit sketch of one of the plants in the type collection, × 1.

Fig. 2. *Mimulus Lewisii* Pursh; habit, × 1.

Fig. 3. *Mimulus primuloides* Benth.; habit, × 1.

Fig. 4. *Mimulus guttatus* DC.; habit, × 1.

del. Dr. L. M. Newlon

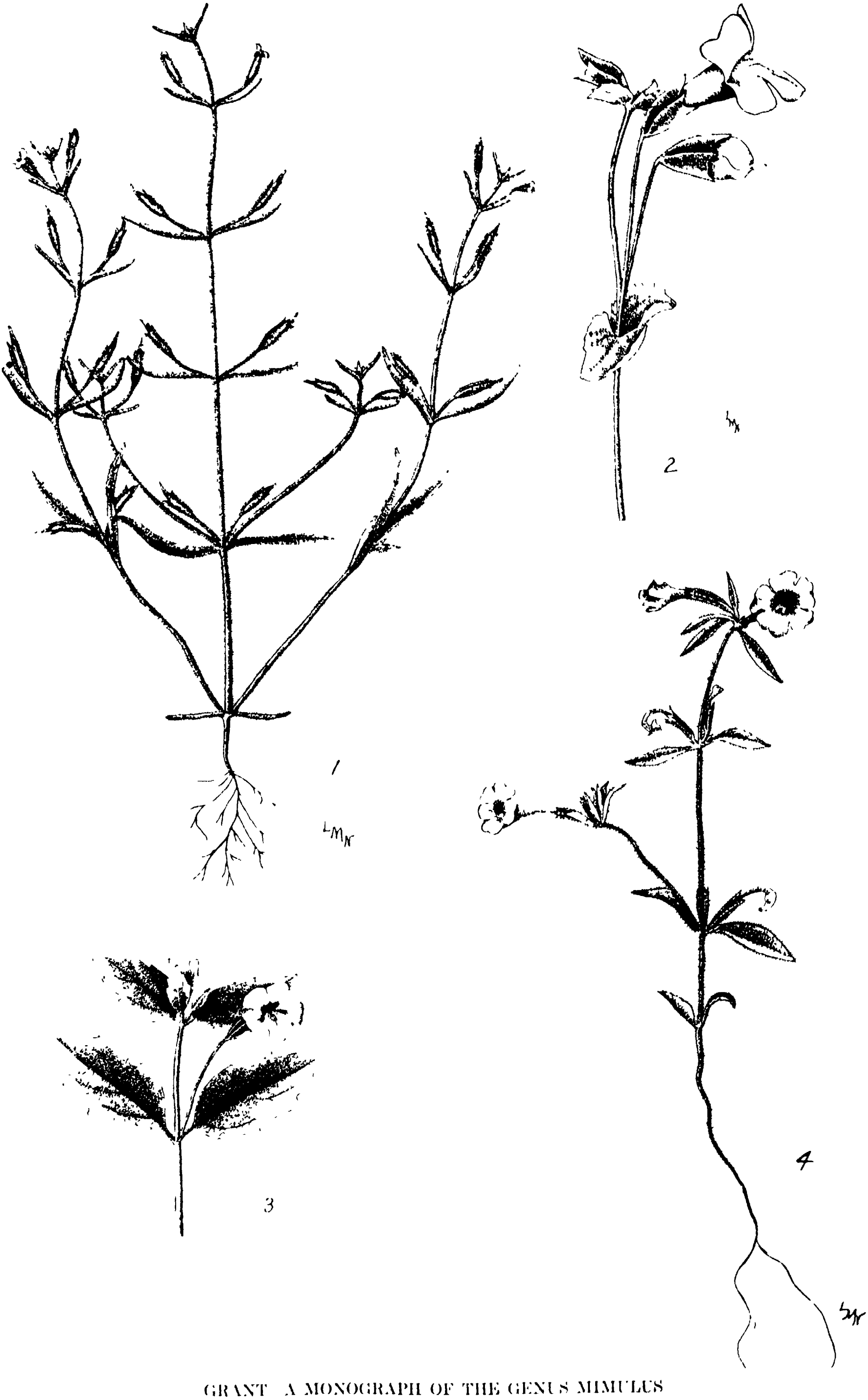
GRANT—A MONOGRAPH OF THE GENUS MIMULUS

Explanation of Plate

PLATE 9

Fig. 1. *Mimulus Breweri* (Greene) Coville; habit, × 1.
Fig. 2. *Mimulus Tilingi* Regel var. *corallinus* (Greene) Grant; habit, × 1.
Fig. 3. *Mimulus moschatus* Dougl. var. *longiflorus* Gray; habit, × 1.
Fig. 4. *Mimulus Layneae* (Greene) Jepson; habit, × 1.

del. Dr. L. M. Newlon



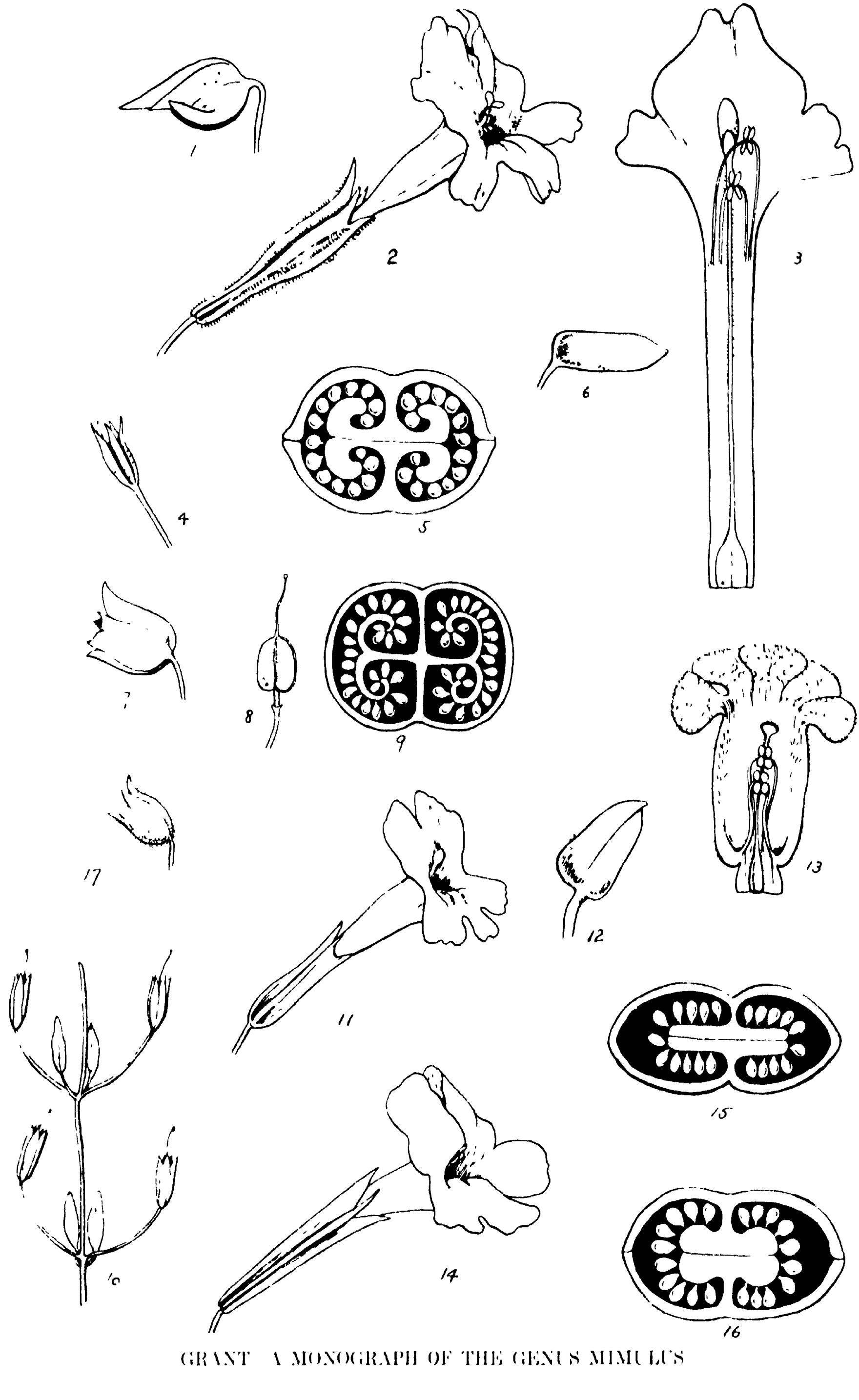
GRANT—A MONOGRAPH OF THE GENUS MIMULUS

EXPLANATION OF PLATE

PLATE 10

Fig. 1. *M. nasutus* Greene, mature capsule, × 1.
Fig. 2. *M. longiflorus* (Nutt.) Grant, flower, × 1.
Fig. 3. *M. Kelloggii* Curran, opened flower, × 2.
Fig. 4. *M. bicolor* Benth., mature calyx, showing the corky ribs, × 1.
Fig. 5. *M. aurantiacus* Curt., cross-section of ovary, × 6.
Fig. 6. *M. Kelloggii* Curran, mature capsule, × 2.
Fig. 7. *M. guttatus* DC. var. *arvensis* (Greene) Grant, mature calyx, × 1.
Fig. 8. *M. guttatus* DC. var. *arvensis* (Greene) Grant, mature ovary, × 4.
Fig. 9. *M. guttatus* DC. var. *arvensis* (Greene) Grant, cross-section of ovary, × 6.
Fig. 10. *M. Pulsiferae* Gray, habit sketch showing the mature calyces and pedicels, × 1.
Fig. 11. *M. puniceus* (Nutt.) Steud., flower, × 1.
Fig. 12. *M. tricolor* Lindl., mature capsule, × 2.
Fig. 13. *M. mohavensis* Lemmon, opened flower, × 2.
Fig. 14. *M. aurantiacus* Curt., flower, × 1.
Fig. 15. *M. tricolor* Lindl., cross-section of ovary, × 6.
Fig. 16. *M. Torreyi* Gray, cross-section of ovary, × 24.
Fig. 17. *M. subsecundus* Gray, mature calyx, × 1.

del. Miss Joyce Saunders



GRANT—A MONOGRAPH OF THE GENUS MIMULUS

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LEUCOGASTER AND LEUCOPHLEBS IN NORTH AMERICA

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LEUCOGASTER

Leucogaster Hesse, Jahrb. f. wiss. Bot. **13**: 189–194. 1882; Bot. Centralbl. **40**: 1–4, 33–36. 1889; Hypog. Deutschl. **1**: 68–71. 1891; Saccardo, Syll. Fung. **9**: 281. 1891, **14**: 249. 1899, **17**: 240. 1905; Fischer in Engler & Prantl, Nat. Pflanzenfam. I. **1****: 311. 1899; Hollós, Magyarország Földalatti Gombai, 97–99. 1911.—*Leucophleps* Harkness, Cal. Acad. Sci. Proc. Bot. III. **1**: 257–259. 1899 (in part).

The type species of the genus is *Leucogaster liosporus* Hesse.

Fructifications globose to irregular, hypogaeous to emergent, fleshy or waxy; fibrils sometimes present, leading to rhizomorphs; columella, stipe, and sterile base absent; peridium usually thin and fragile, sometimes rupturing at maturity; cavities frequently polyhedral, usually filled with spores embedded in a gelatinous mass; septa homogeneous, with or without a distinct trama, often gelatinizing at maturity; basidia from subglobose to ovoid and subcylindric, mostly 4-spored, sometimes 3- or 5-spored; spores hyaline or slightly colored, with various surface markings embedded in a gelatinous spherical mass.

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Leucogaster was placed by its author next to *Melanogaster* Corda, because the basidia are in less definitely organized layers than in the other genera of the *Hymenogastraceae,* while Fischer, considering its inseparable peridium and spore characters, placed it between *Hydnangium* Wallroth and *Rhizopogon* Fries. In several species the basidia are long-pedicellate, a fact which, in the absence of cystidia or paraphyses, often give them the appearance of being scattered throughout the cavity, especially where the razor tangles the long, thread-like pedicels. The basidium is usually little more than the slightly enlarged end of a hypha and frequently much smaller than one of the spores produced by it. In the development of the sporophore cavities seem to be formed in the outer sterile layer of the gleba when the hyphae cease to elongate and produce basidia at the ends of the hyphae, while the surrounding hyphae elongate rapidly, separating the basidia. A gel, which is either secreted or formed by the disintegration of many of the hyphae in the cavity, fills the cavity and oozes out as a milky liquid when the fructification is cut open. The peridium is thin and usually homogeneous with the gleba. It is variable in thickness, owing to the manner in which the new cavities are formed.

Fischer[1] has recently described development in *Leucogaster floccosus* Hesse. He finds the cavities not lined with a hymenium in the youngest stage studied (3.5 × 2.5 mm.) but filled with loose tissue of thin-walled hyphae which show marked but wholly irregular swelling and form a loose pseudoparenchyma. The trama consists of parallel, thin-walled, interwoven hyphae. In a later stage (11 × 4–5 mm. in diameter) the cavity has nearly disappeared in a formless gel and the basidia push out into it from the septa.

Fischer evidently studied *L. floccosus* Hesse, although he was not sure that it might not have been *L. fragrans* Mattirolo. A study of the type of the latter shows it to be quite distinct from *L. floccosus,* although it falls into synonymy elsewhere (see p. 403). In the Farlow Herbarium there is a collection of *L. floccosus* from Hesse, dated 1900, which agrees with the description very well.

[1] Fischer, E. Mykologische Beiträge, 25. Jugendstadien des Fruchtkörpers von Leucogaster. Naturf. Ges. Bern, Mitt. **1921**: 301–307. (20–26). 1922.

It contains 3 large and 2 small fructifications, one of the latter 2×3 mm. in diameter, the other 4×5 mm. They have been preserved in alcohol since 1900 and probably are somewhat shrunken. When collected they were probably about the age of those examined by Fischer. In the smaller specimen the cavities are filled with cells, somewhat irregular on account of mutual pressure, which expand to a spherical form when treated with a dilute solution of potassium hydroxide. A further study shows them to be spores (?) borne acrogenously on short branches of curved or zig-zag hyphae, or sometimes terminally on large hyphae springing from the trama (see pl. 11, fig. 10). When closely packed together they appear in rows, reminding one of the appearance of aecidiospores of the *Uredinales*. As the only material available was no longer viable, whether these organs are true spores must remain in doubt for the present.

Secondary spore forms have not been reported very frequently in *Gasteromycetes*. Fischer[1] has reported cells which he called gemmae in *Sphaerobolus*, and Eidam[2] and Brefeld[3] found that oidia are produced in poorly nourished cultures of the *Nidulariaceae*. In the *Hymenomycetes* most of the literature has been carefully reviewed by Lyman,[4] Zeller[5] and Snell,[6] who show that other spore forms are much more common in these fungi. We[7] have already noted conidia-like cells produced at the surface of *Arcangeliella caudata* Z & D., although we did not attempt to germinate them. The spores of the present fungus resemble the basidio-

[1] Fischer, E. Zur Entwickelungsgeschichte der Gasteromyceten. Bot. Zeit. **42:** 433-443, 449-462, 465-475, 485, 494. *pl. 7.* 1884.

[2] Eidam, E. Die Keimung der Sporen und die Entstehung der Fruchtkörper bei den Nidularieen. Beitr. z. Biol. d. Pflanzen **2:** 221-249. *pl. 10.* 1876.

[3] Brefeld, O. Botanische Untersuchungen uber Schimmelpilze **3:** 1-226. *pl. 1-11.* 1877.

[4] Lyman, G. R. Culture studies on polymorphism of Hymenomycetes. Boston Soc. Nat. Hist., Proc. **33:** 125-209. *pl. 18-26.* 1907.

[5] Zeller, S. M. Studies in the physiology of the fungi. II. Lenzites saepiaria Fries, with special reference to enzyme activity. Ann. Mo. Bot. Gard. **3:** 439-512. (See pp. 443-444). *pl. 8-9.* 1916.

[6] Snell, W. H. Studies of certain fungi of economic importance in the decay of building timbers with special reference to the factors which favor their development and dissemination. U. S. Dept. Agr. Bull. 1053: 1-47. *pl. 1-8.* 1922.

[7] Zeller, S. M., and Dodge, C. W. Arcangeliella, Gymnomyces, and Macowanites in North America. Ann. Mo. Bot. Gard. **6:** 49-59. 1919.

spores so closely on account of the thick gelatinous sheath that they may be mistaken for the latter. In *Leucophlebs candida* Harkness, one finds that the spore frequently has slipped out of its sheath, reminding one of the germination of the chlamydospores of *Fistulina*, reported by de Seynes.[1]

In 1899 Harkness described a new genus, *Leucophlebs*, based on 5 species, 3 of which are undoubtedly *Leucogaster* sp. The types of the 2 remaining species are in such a collapsed condition that it is difficult to interpret the structure, but apparently they are the imperfect condition of *Leucogaster*. For the present we would leave this genus among the *Fungi Imperfecti*, analogous to *Ceriomyces* Corda[2] (*Ptychogaster* Corda), a chlamydosporic stage of *Polyporus* Micheli ex Fries, in so far as the species have been connected with any perfect stage.

The relationships of *Leucogaster* and *Scleroderma* in connection with the forms originally described as *Phlyctospora* offer an opportunity for further investigation by those having access to young material. There seems to be a series of forms from such species as *Leucogaster luteomaculatus* and *L. floccosus* with their duplex peridia, through such forms as *L. citrinus* to *L. badius*, thence to *Scleroderma* (*Phlyctospora*) *fuscum* and *S.* (*Euscleroderma* ?) *dictyosporum* and *S.* (*Euscleroderma*) *aurantium*, in which there is a gradual thickening of the peridium, a thickening of the gelatinous envelope of the spore with a simultaneous increase in the depth of the warts and reticulations, which finds its most complete expression in the subgenus *Phlyctospora* of *Scleroderma*, and a sudden disappearance of the gelatinous sheath in the subgenus *Euscleroderma*. Observations on the development of *Scleroderma hypogaeum* Zeller by one of us show that the spores of this species are at first surrounded by a thick gelatinous sheath which, upon maturity and drying, disappears. Further, it will be noted that in the above series of forms, all stages are represented, connecting forms with a well-defined and definitely organized hymenium with those in which the basidia are scattered throughout the

[1] de Seynes, J. Recherches pour servir à l'histoire naturelle des végétaux inférieurs. I. Des Fistulines. v+71 pp. 7 *pl.* Paris, 1874.

[2] Not Battara. *Ceriomyces* Battara has been used as a segregate of *Boletus* Fries (see North American Flora 9: 136. 1910).

tissue. The series also illustrates a progression from forms which gelatinize throughout to those which finally become dry and dusty at maturity. Until a morphological study can be made, it seems wise to consider all forms with light-colored and hyaline spores enclosed in a definite, globose, gelatinous sheath as species of *Leucogaster*, reserving the dark-colored spore groups for the subgenus *Phlyctospora* of *Scleroderma*.

As in our previous work, we have used as a standard for color descriptions Ridgway, 'Color Standards and Color Nomenclature,' Washington, D. C., 1912. In citing specimens we have given the data accompanying the specimens. Wherever possible the location of the specimens has also been given.

In conclusion we gratefully acknowledge our indebtedness to all who have aided us in this work. We are indebted to the Missouri Botanical Garden for the use of the library and herbarium; to Dr. L. R. Abrams for access to the Dudley Herbarium at Leland Stanford Jr. University, and to Prof. J. McMurphy for assistance in the study of Harkness' specimens there; to Dr. E. A. Burt for access to his private herbarium and for helpful suggestions; to the late W. G. Farlow for access to the collections from Hesse in the Cryptogamic Herbarium of Harvard University, and, since Dr. Farlow's death, to Dr. R. Thaxter for helpful suggestions and for access to his own collections as well as those of the Farlow Herbarium; to Dr. H. D. House for the privilege of studying the type of *Hymenogaster anomalus* Peck from the New York State Museum; to Mr. C. G. Lloyd for access to specimens in the Lloyd Museum; to Mr. H. E. Parks for assistance in collecting fresh material; and to Dr. W. A. Setchell and to Dr. N. L. Gardner for access to the University of California Herbarium.

Key to the Species of Leucogaster and Leucophlebs

1. Peridium duplex, thin, 60–80 μ thick, white spotted with yellow, becoming reddish on drying, basidia linear-oblong.......................... *Leucogaster luteomaculatus* (p. 394)
1. Peridium simplex, although sometimes with flocculent patches, then much thicker.. 2
    2. Spores over 16 μ in diameter.............................. *L. nudus* (p. 404)
    2. Spores under 16 μ in diameter.. 3
3. Peridium of large hyphae (more than 4 μ in diameter)........................ 4
3. Peridium of slender hyphae.. 6

4. Septa of long hyphae, peridium very thick..........*L. liosporus* (p. 402)
4. Septa of pseudoparenchyma, peridium 140–220 μ thick............. 5
5. Spores reticulate..*L. Tozziana* (p. 403)
5. Spores aculeate.... ....*L. Bucholtzii* (p. 404)
6. Peridium thin (under 180 μ thick)............................ 7
6. Peridium thick (over 200 μ thick)........ 12
7. Septa thick, 100–150 μ thick, gleba becoming bay or darker.*L. floccosus* (p. 402)
7. Septa medium, 75–100 μ thick, gleba white.. 8
7. Septa thin, 20–50 μ thick 9
8. Cavities empty, subhymenial layer compact........*L. odoratus* (p. 396)
8. Cavities filled, subhymenial layer loosely woven..*L. foveolatus* (p. 397)
9. Peridium 15–20 μ thick, surface studded with shallow depressions, white ....*Leucophlebs candida* (p. 407)
9. Peridium 120–180 μ thick 10
9. Peridium 15–60 μ thick, pseudoparenchymatous, red.................. ....*Leucogaster rubescens* (p. 395)
10. Peridium containing pigmented bodies, citron-yellow..*L. citrinus* (p. 398)
10. Peridium uniform.. 11
11. Septa of 3 indefinite layers, basidia long-pedicelled, paraphyses none, giving the hymenium an arachnoid appearance, sterigmata short . ... *L. araneosus* (p. 399)
11. Septa thinner, homogeneous, spores 13 μ in diameter, "sterigmata "long ... .*Leucophlebs magnata* (p. 406)
12. Septa thin, 60–120 μ thick, basidia clavate, 22×8 μ, spores 11–13 μ in diameter, sterigmata short........ .*Leucogaster anomalus* (p. 399)
12. Septa thick, 150–200 μ thick, basidia pyriform.. 13
13. Basidia 20–24×12 μ, spores 12–16 μ in diameter, sterigmata short ....*L. badius* (p. 400)
13. Basidia 7–8×5–6 μ, pedicellate, spores 8–10 μ in diameter, sterigmata long ....*L. fulvimaculosus* (p. 401)

1. Leucogaster luteomaculatus Zeller & Dodge, sp. nov.

Fructificationes globosae, 2.5 × 1 cm. metientes, siccatae 1.5 × 0.8 cm., recentes calceae, cum maculis sordide luteis (Thaxteri memoranda), siccatae "ox-blood red" vel "garnet-brown" (Ridgway), superficie inaequali, nitenti; funiculi anastomosantes, hinc indeque liberi, nigri, nitentes; peridium 60–80 μ crassitudine, duplex, strato extero facile ab intero separante pannis relictis, 20–30 μ crassitudine, hyphis crassis, septatis, olivaceis-brunneis sub lente, contexto, strato intero 40–50 μ crassitudine, hyphis tenuibus, badiis, granulatis, dense contexto; gleba lactea recens (Thaxtero teste), siccata "cinnamon" vel "clay-color" (Ridgway); locelli globosi vel angulosi, impleti; septa tenua, 50–60 μ crassitudine, hyalina, hyphis parallelis, crassis, tenuibus cum parietibus, hyalinis contexta, scissilia; basidia hyalina, 7 × 12 μ, anguste oblonga, bispora; sterigmata 2–4 μ longitudine; sporae dilute olivaceae sub lente, globosae, minute verrucosae in vaginis gelatinosis inclusae, 7–9 μ.

Habitat sub foliis in fagetis, Carolina boreali. Aestate.

Type: in Thaxter Herb.

Fructifications globose, 2.5 × 1 cm., drying 1.5 × 0.8 cm., chalk-white with yellow flecks (Thaxter's field notes), becoming

ox-blood red to garnet-brown on drying, surface uneven, shining; fibrils anastomosing, free in places, black, shining; peridium 60–80 μ thick, duplex, outer layer readily separating from the inner, leaving patches 20–30 μ thick, of large, septate, olive-brown hyphae; inner layer 40–50 μ thick, of slender, reddish brown, granular, closely woven hyphae; gleba milk-white when fresh, drying cinnamon or clay-color; cavities globose to polyhedral, filled; septa thin, 50–60 μ, hyaline, of large, parallel, thin-walled, hyaline hyphae, scissile; basidia hyaline, 7 × 12 μ, narrowly oblong, 2-spored; sterigmata 2–4 μ long; spores light olivaceous under the microscope, globose, minutely verrucose with a gelatinous sheath, 7–9 μ in diameter.

Under leaf mould in beech forests. Europe and North America. Summer.

The duplex character of the peridium, the color both when fresh and upon drying, as well as the very thin peridium, should serve to distinguish this species from other members of the genus.

Specimens examined:

Exsiccati: D. Saccardo, Mycoth. Ital., 1424.

Switzerland: *E. Butignot* (in Lloyd Mus. 025).

Italy: Firenze, Vallombrosa, *A. Fiori* in D. Saccardo, Mycoth. Ital., 1424 (in Farlow Herb. at Harvard Univ.).

North Carolina: Cranberry, *R. Thaxter*, *3*, type (in Thaxter Herb. and in Farlow Herb. at Harvard Univ.).

California: Santa Clara County, *H. E. Parks*, *908* (immature) and *915* (in Univ. Cal. Herb., and in Dodge Herb. 2104).

2. **Leucogaster rubescens** Zeller & Dodge, sp. nov.

Fructificationes subglobosae vel irregulares, primum albidae vel carneae, deinde "brick-red" vel "Hessian brown" (Ridgway), superficie levi vel inaequali, viscida; funiculi concolores saturatioresve, innati-appressi; peridium 15–35 μ crassitudine (aliquando 40–60 μ) pseudoparenchymate gelatinoso, fragile, "orange rufous" (Ridgway) siccatum; gleba siccata cremea vel "ivory-yellow" (Ridgway) secata; locelli circa 0.5 mm, globosi vel angulosi; septa hyalina, 35–55 μ crassitudine, hyphis tenuibus scissilescentibus; basidia hyalina, pyriformia, 15–25 × 8–14 μ, pedicello 50–125 μ longitudine, tetraspora, sterigmatibus 2–4 μ longitudine; sporae sphaericae oblongaeve, echino-reticulatae, subhyalinae, 11–15 μ (cum vagina gelatinosa, 6–10 μ sine vagina).

Sub foliis in aceretis. Oregon. Veri.

Type: in Zeller Herb., Dodge Herb., and Oregon Agr. Coll. Herb.

Fructifications subglobose to irregular, at first whitish to flesh-pink, becoming brick-red to Hessian brown, surface smooth, uneven, viscid when moist; fibrils concolorous or darker, innate-appressed; peridium usually 15–35 μ thick (sometimes 40–60 μ), composed of gelatinized pseudoparenchyma, drying brittle and orange rufous, lined with the fine, hyaline hyphae of the outer layer of the gleba (showing white in cross-section); gleba drying cream-color or ivory-yellow when cut after drying; cavities averaging about 2 to the mm., globose to polyhedral, lined with a clear gelatinous mucus, embedding the long-pedicelled basidia and spores; septa hyaline, 35–55 μ thick, of thin-walled hyphae, becoming scissile; basidia not in a definite hymenium, hyaline, pyriform, 15–25 × 8–14 μ, on pedicels 50–125 μ long, 4-spored; sterigmata 2–4 μ long; spores spherical to oblong, echino-reticulate, almost hyaline, 11–15 μ (including gelatinous sheath), spore alone 6–10 μ.

In leaf mould under maples. Oregon. May.

The thin pseudoparenchymatous peridium, which is vivid red, and the echino-reticulate spores separate this species from others of the genus.

Specimens examined:

Oregon: Corvallis, *L. M. Boozer*, type (in Oregon Agr. Coll. Herb. 3706, in Zeller Herb. 2322, and in Dodge Herb. 2072).

3. **Leucogaster odoratus** (Harkness) Zeller & Dodge, comb. nov.

Leucophleps odorata Harkness, Cal. Acad. Sci. Proc. Bot. III. **1**: 258. 1899; Saccardo & Sydow in Sacc. Syll. Fung. **16**: 252. 1902.

Illustrations: Harkness, Cal. Acad. Sci. Proc. Bot. III. **1**: *pl. 43. f. 9;* Rev. Myc. **22**: *pl. 204. f. 12.*

Type: in Dudley Herb. at Leland Stanford Jr. Univ.

Fructifications oblong or irregularly lobed, large, 3–4 cm. in diameter, light orange, fading in alcohol; fibrils and columella wanting; peridium thin, about 100 μ thick, of compactly woven, gelatinized hyphae, homogeneous with the septa; gleba white, cavities round, empty; septa about 75 μ thick, of 3 layers, the middle layer of parallel, gelatinized hyphae, subhymenial layers of closely interwoven hyphae, hymenium of long-pedicelled

basidia, 20 × 5 μ; no paraphyses; sterigmata short; spores hyaline, reticulate in gelatinous sheath, globose to slightly ellipsoidal, 8–11 μ in diameter.

California. June to July.

The freshly cut gleba exudes a milky juice, probably a dense suspension of spores, as no definite latex organs were seen. This, with the large, spherical empty cavities and its color, makes it quite easy to recognize in the field.

Specimens examined:

California: Shasta County, Castle Crag, *H. W. Harkness, 251*, type (in Dudley Herb. at Leland Stanford Jr. Univ.); Santa Clara County, Saratoga, Boys' Outing Farm, *H. E. Parks & C. W. Dodge* (in Dodge Herb. 1529).

4. **Leucogaster foveolatus** (Harkness) Zeller & Dodge, comb. nov.

Leucophleps foveolata Harkness, Cal. Acad. Sci. Proc. Bot. III. **1**: 258. 1899; Saccardo & Sydow in Sacc. Syll. Fung. **16**: 252. 1902.

Type: in Dudley Herb. at Leland Stanford Jr. Univ.

Fructifications subglobose, 1 cm. in diameter, white or faintly citron color; fibrils few, small, white; columella wanting; peridium thin, 75 100 μ thick, of very slender, compactly woven hyphae, homogeneous with the septa which show through as reticulations or pits on the surface; gleba white, cavities rounded, filled with hyphae; septa 75–100 μ thick, of 3 layers, the middle layer of compactly woven, gelatinized hyphae, subhymenial layer of larger, more loosely woven hyphae; basidia clavate, 12 × 7 μ, disappearing, leaving spores sticking to walls of the cavity hyphae; sterigmata long; spores hyaline, guttulate, reticulate in a gelatinous sheath, sometimes slipping out at maturity, globose to slightly ellipsoidal, 7–12 μ.

Moist earth. British Columbia to California. July to September.

Leucophlebs gibbosum Harkness, herb. nom., is a lighter form, irregular in shape but structurally similar (Harkness 124, without locality data in Dudley Herb. at Leland Stanford Jr. Univ.).

Specimens examined:

British Columbia: south of Beavermouth along Quartz Creek Trail, *C. W. Dodge, 1545* (in Dodge Herb.).

California: Marin County, Mill Valley, *H. W. Harkness, 209*, type (in Dudley Herb. at Leland Stanford Jr. Univ.).

5. **Leucogaster citrinus** (Harkness) Zeller & Dodge, comb. nov.

Leucophleps citrina Harkness, Cal. Acad. Sci. Proc. Bot. III **1**: 259. 1899; Saccardo & Sydow in Sacc. Syll. Fung. **16**: 252. 1902.

Illustrations: Harkness, Cal. Acad. Sci. Proc. Bot. III. **1**: *pl. 43, f. 8;* Rev. Myc. **22**: *pl. 204, f. 10–11.*

Type: in Dudley Herb. at Leland Stanford Jr. Univ.

Fructifications solitary, subglobose, 2 cm. in diameter, "citron color, imparting a reddish color to alcohol when immersed" (Harkness), becoming dirty vinaceous buff when dry; peridium 140–170 μ thick, composed of uniform, small, closely woven hyphae, appearing light chalcedony-yellow, homogeneous except for included sand and globose to irregular pigmented bodies, 12–20 μ in diameter, appearing granular, tawny to buckthorn-brown; gleba ivory-yellow when dry; cavities large, globose, empty; septa 20–30 μ thick between hymenial layers, composed of very slender, closely woven, hyaline hyphae; basidia narrowly clavate, 16–25 × 2–4 μ, hyaline, filled with oil globules, 2–4-spored; sterigmata 5–7 μ long, slender; spores brown in mass, sybhyaline under the microscope, pitted or minutely verrucose, 7–11 μ in diameter, surrounded by a gelatinous sheath approximately 1–2 μ thick.

Under manzanita and laurel. California. April.

Cremogaster levisporus Mattirolo agrees with this species in all respects except that it is slightly younger material and the spore is scarcely pitted yet.

Specimens examined:

California: Marin County, Mt. Tamalpais, *H. W. Harkness, 168*, type (in Dudley Herb. at Leland Stanford Jr. Univ. and in Farlow Herb. at Harvard Univ.); Santa Clara County, Saratoga, Boys' Outing Farm, *Dale Parks* (in Univ. Cal. Herb., under H. E. Parks, 816); Call of the Wild, *H. E. Parks, 37b* (in Univ. Cal. Herb.); San Antonio Mts., *I. M. Johnston*, type of *Cremogaster levisporus* Mattirolo (in Lloyd Mus.).

6. Leucogaster araneosus Zeller & Dodge, sp. nov.

Fructificationes globosae, 0.6 cm. in diametro metientes, servatae "snuff-brown" vel "bister" (Ridgway); funiculi magni sed non prominentes, pauci, semi-innati, subramosi; peridium 130–180 μ crassitudine, simplex, hyphis dilute brunneis tenuissimis dense contextum; gleba alba, fulvis cum maculis; locelli subglobosi, impleti; septa tenua, 40–50 μ crassitudine inter hymenia, compacta, stratis tribus composita, strato medio dilute brunneo, stratis caeteris hyalinis; stratum hymeniale quasi araneosum (unde nomen); paraphyses nulli; basidia hyalina, granulato-guttulata, 8–10 × 6–8 μ, piriformia, in pedicellis ad 300 μ longitudine imposita, tetraspora; sporae hyalinae, globosae, alveolato-reticulatae, angulis alveolarum prominentibus velut spinis obtusis, in vaginis gelatinosis inclusae, 8–11 μ in diametro.

Habitat in Carolina boreali. Aestate.

Type: in Thaxter Herb.

Fructifications globose, 0.6 cm. in diameter in preserved material, snuff-brown to bister; fibrils large but not prominent, few, half-immersed, somewhat branched; peridium 130–180 μ thick, simplex, of closely woven, very slender, light brown hyphae; gleba white with tawny spots; cavities subglobose, filled; septa thin, 40–50 μ thick between hymenia, compact, of 3 layers, the middle layer being light brown, the other 2 layers hyaline; hymenial layer arachnoid; paraphyses none; basidia hyaline, granulate-guttulate, 8–10 × 6–8 μ, pyriform, on pedicels up to 300 μ long, 4-spored; spores hyaline, globose, alveolate-reticulate, angles of alveoli projecting as blunt spines, in a gelatinous sheath, 8–11 μ in diameter.

North Carolina. Summer.

Specimens examined:

North Carolina: Cranberry, *R. Thaxter, 96* (in Thaxter Herb. and Farlow Herb. at Harvard Univ.).

7. Leucogaster anomalus (Peck) Zeller & Dodge, comb. nov.

Hymenogaster anomalus Peck, N. Y. State Mus. Bull. 116: 31–32. 1907 (also cited as N. Y. State Ed. Dept. Bull. 404: 31–32. 1907, and as Rept. State Botanist [N. Y.] **1906**: 31–32. 1907); Saccardo & Trotter in Sacc. Syll. Fung. **21**: 496. 1912.

Type: in Coll. N. Y. State and in U. S. Nat. Herb.

Fructifications globose to irregular, 1–2.5 cm. in diameter, cinnamon-buff, clay-color, and tawny olive to Mikado brown above, Hay's russet and liver-brown below, "glabrous, slightly lacunose, often with a root-like strand of mycelium at the base,

. . . sterile base obsolete or nearly so, odor slight, not disagreeable," (Peck); peridium 240–520 μ thick, grenadine to English red near the surface to hyaline within, composed of very slender interwoven hyphae; gleba amber-brown to Sudan brown, sometimes lighter; cavities large, mostly more than 1 mm. in diameter, subglobose to irregular, empty; septa 60–120 μ, composed of very closely woven, hyaline hyphae, not scissile; cystidia none, paraphyses clavate, granularly guttulate; basidia clavate, 22–24 × 8 μ, hyaline, 4-spored; spores almost sessile, dilute cream-colored to hyaline, globose, 11–13 μ in diameter, uninucleate, surface pitted, giving the appearance of hexagonal reticulations, surrounded by a hyaline, gelatinous sheath.

Hypogaeous, in woods. District of Columbia. August to September.

Specimens examined:

District of Columbia: Washington, Rock Creek Park, *T. E. Wilcox*, type (in Coll. N. Y. State and U. S. Nat. Herb.).

8. **Leucogaster badius** Mattirolo, R. Accad. Sci. Torino, Mem. II. **53**: 356. 1903; Saccardo & Saccardo in Sacc. Syll. Fung. **17**: 240. 1905.

Illustrations: Mattirolo, R. Accad. Sci. Torino, Mem. II. **53**: *pl. unnumbered, f. 1–3.*

Type: probably in Mattirolo Herb. and in Collezione Beccari, Herb. Cesatiano at the R. Ist. Bot. di Roma, but not seen.

Fructifications subglobose, 1 cm. in diameter, raw sienna to raw umber, surface pitted, glabrous; stipe very slender, from a very slight, inconspicuous, sterile base; peridium 200–340 μ thick, ochraceous-buff, stupose, composed of very slender hyphae; gleba raw umber; cavities polygonal, filled with spores in a gelatinous mass due to deliquescence, 0.7–1.0 mm. in diameter; septa 160–200 μ thick, composed of compactly woven, gelatinous, cream-colored hyphae; cystidia none; basidia hyaline, pyriform, 20–24 × 12 μ, 4-spored, guttulate; spores almost sessile, subglobose, 12–16 μ in diameter, cream-colored, surface pitted, giving the appearance of hexagonal reticulations, surrounded by a hyaline, gelatinous sheath.

On the ground, under leaves. Italy and New York, July and August.

Specimens examined:
New York: East Galway, *E. A. Burt* (in Burt Herb.).

9. Leucogaster fulvimaculosus Zeller & Dodge, sp. nov.

Fructificationes globosae, 2.0–2.5 cm. in diametro metientes, siccatae "cinnamon buff," "tawny" (Ridgway) maculatae; funiculi non prominentes, pauci, concolori; peridium 375–425 μ crassitudine, simplex, compactum, hyphis tenuibus dense contextum; gleba "warm buff" (Ridgway) vel dilutior; locelli globosi vel angulosi, semi-impleti; septa 150–180 μ crassitudine, hyalina, hyphis tenuibus dense contexta, non scissilia; basidia hyalina, 7–8 × 5–6 μ, piriformia, in pedicellis 90 μ longitudine imposita, trispora; sterigmata conica, 2 μ longitudine; sporae hyalinae servatae, brunneae siccatae, sphericae vel ovoideae, verrucosae vel reticulatae, in vaginis gelatinosis inclusae, 8–10 μ diametro.

Habitat in silvis udosis. Civ. Noveboracensi. Aestate.

Fructifications globose, 2.0–2.5 cm. in diameter, drying cinnamon-buff, spotted with tawny; fibrils not prominent, few, concolorous; peridium 375–425 μ thick, simplex, compact, of closely woven, slender hyphae; gleba warm buff or lighter; cavities globose or polyhedral, half filled; septa 150–180 μ thick, hyaline, of closely woven slender hyphae, not scissile; basidia hyaline, 7–8 × 5–6 μ, pyriform, on pedicels about 90 μ long, 3-spored; sterigmata conical, 2 μ long; spores hyaline in preserved material, brown in dry material, spherical to ovoid, verrucose to reticulate, leaving a pore where detached from the sterigma, inclosed in a gelatinous sheath, 8–10 μ in diameter.

Damp woods. New York. Summer.

The peridium of this species appears to be variable in thickness, new cavities seeming to form in the inner layer as the fructification increases in size, with the hyphae next the basidia-bearing hyphae gelatinizing and finally disappearing. A study of young material is very desirable for further interpreting this phenomenon.

Specimens examined:
New York: Long Island, Cold Spring Harbor, *A. F. Blakeslee*, type (in Farlow Herb. at Harvard Univ.).

EXTRA-LIMITAL SPECIES

The following species of *Leucogaster* have not yet been noted from North America, but are included in order to assist in referring material to them in case they should be found later, as individual species in this family have wide ranges.

1. **Leucogaster liosporus** Hesse, Jahrb. f. wiss. Bot. **13**: 190. 1882; Hypog. Deutschl. **1**: 70–71. 1891; Saccardo, Syll. Fung. **9**: 281. 1891.—*Octaviania silesiaca* Becker, Die Natur **35**: 356. 1886, fide Schroeter in Cohn, Kryptog.-Fl. von Schlesien **3**^{1}: 710–711. 1889.—*Octaviania* ? *Gautieria* ? *pityophila* Becker, Die Natur **35**: 356. 1886, fide Schroeter in Cohn, Kryptog.-Fl. von Schlesien **3**^{1}: 710–711. 1889.

Illustrations: Hesse, Jahrb. f. wiss. Bot. **13**: *f. 1–6;* Hypog. Deutschl. **1**: *pl. 3. f. 14–15.*

Type: location unknown to us.

Fructifications very irregular, variable in size, citron-yellow, odor none; fibrils free, branched, becoming 3 mm. thick at maturity; peridium thick, 1.5–2.5 mm. thick when fresh (teste Hesse), 100–140 μ when preserved in alcohol, smooth, composed of thick yellowish hyphae; gleba white; cavities polygonal, larger at the center than at the peridium, filled at maturity; septa composed of long, thin hyphae; basidia broadly clavate to subglobose; sterigmata very short; spores 12 μ in diameter, rough, surrounded by a gelatinous sheath.

In birch woods. Central Europe.

A specimen in the von Hoehnel Herbarium, 2605a, agrees with the description of this species, except that the cavities are elongated radially from the base, as Hesse has figured in one case for *L. floccosus*, and are not filled at maturity. The *Leucophlebs* stage of this specimen shows spores borne terminally on short branches of the cavity hyphae. These spores resemble basidiospores but have smoother and thinner walls and small germ pores. The sporiferous branch of a cavity hypha usually remains attached to the spore.

Specimens examined:

Austria: Reinberg bei Altenmarkt, Coronnathal, *Fr. von Hoehnel, 2605a* (in von Hoehnel Herb. at Farlow Herb., Harvard Univ.).

2. **Leucogaster floccosus** Hesse, Bot. Centralbl. **40**: 1–4, 33–36. 1889; Hypog. Deutschl. **1**: 68–70. 1891; Saccardo, Syll. Fung. **9**: 281. 1891.

Illustrations: Hesse, Bot. Centralbl. **40**: *pl. 1, 2. f. 1–9;* Hypog.

Deutschl. **1**: *pl. 3, f. 8–13; pl. 5, f. 8; pl. 7, f. 1–3; pl. 8, f. 1–20; pl. 9, f. 1–13.*

Type: location unknown to us.

Fructifications irregular, variable in size, light yellow (Hesse), bay to auburn in alcohol; fibrils loose, round, black or nearly so; peridium with thick, flocculent concolorous patches, 120–150 μ thick, composed of small hyphae, outer ones colored to a depth of 10 μ, inner ones gelatinizing; gleba slightly darker, waxy in preserved specimens; septa hyaline, 100–150 μ, composed of large, closely woven hyphae; basidia 2–3-spored, 7 × 12 μ; spores echinulate, 4 μ in diameter, surrounded with a gelatinous sheath, making a total diameter of 7–10 μ.

Hypogaeous in birch and oak woods, England and Germany. August and September.

Specimens examined:

Exsiccati: Rabenhorst, Fung. Eur. 38.

England: Batheaston, *C. E. Broome* (in Rabenhorst, Fung. Eur., 38, under the name *Hymenogaster citrinus* Vitt., copy in Farlow Herb. at Harvard Univ.).

Germany: Hesse-Nassau, Kirchain, *R. Hesse, 1902* (in Farlow Herb. at Harvard Univ.).

3. Leucogaster Tozziana (Cavara & Saccardo) Mattirolo in litt., comb. nov.

Endogone Tozziana Cavara & Saccardo, Nuov. Giorn. Bot. Ital. II. **7**: 296. Jy. 1900; Saccardo & Sydow in Sacc. Syll. Fung. **16**: 816–817. 1902.—*Leucogaster* sp. Baccarini, Nuov. Giorn. Bot. Ital. II. **10**: 80. 1903; Thaxter, Am. Acad. Arts & Sci., Proc. **57**: 326. 1922.—*Leucogaster fragrans* Mattirolo, Malpighia **14**: 267. Dec. 1900; Saccardo & Sydow in Sacc. Syll. Fung. **16**: 249. 1902.

Type: in Cavara Herb. and portion in Mattirolo Herb.

Fructifications irregular or gibbous, sulcate, 1–2.5 cm. in diameter, sulphur-colored, becoming vinaceous buff or darker in alcohol; odor of *Tuber Borchii* (Mattirolo); fibrils adherent to almost free, concolorous, sometimes surrounding the fructification, sometimes mostly on the under side; peridium 140–220 μ thick, simplex, composed of large, parallel, thin-walled hyphae, 4–7 μ

in diameter, forming a pseudoparenchyma; gleba white, becoming Sayal brown in alcohol, cavities variable in size, polygonal; septa 40–60 μ thick, composed of pseudoparenchyma much as in the peridium; basidia clavate, 20 × 7 μ, disappearing early; sterigmata 2 μ long; spores globose, 12 μ in diameter, reticulate, surrounded by a gelatinous sheath.

In pine and fir forests. Italy.

Specimens examined:

Italy: Vallombrosa, *O. Mattirolo*, Nov. 23, 1899, cotype of *Leucogaster fragrans* (in Mattirolo Herb. and portion in Thaxter Herb.); *O. Mattirolo*, 1910 and undated specimen (in Lloyd Mus. unnumbered and 064); Nocciuolo sopra Vallombrosa, *F. Cavara*, type (preparation from Mattirolo in Thaxter Herb.).

4. **Leucogaster Bucholtzii** Mattirolo, Malpighia **14**: 267–268. 1900; Saccardo & Sydow in Sacc. Syll. Fung. **16**: 249. 1902.

Type: location unknown to us.

Characters of *L. Tozziana* (Cav. & Sacc.) Matt. with aculeate, instead of reticulate, spores.

In fir forests. Vallombrosa, Italy. Summer.

There seems to be so little in the original description to separate this species from *L. Tozziana* that we are inclined to regard it as a variety of this species, but reserve our decision until authentic material has been studied. It is possible that a careful comparison of collections referable here would show all the variations between fructifications with reticulate spores and those with aculeate ones.

5. **Leucogaster nudus** (Hazslinszky) Hollós, Mus. Nat. Hungarici, Ann. **6**: 319. 1908; Magyarország Földalatti Gombai 98, 208. 1911 (excl. syn.).—*Hydnangium nudum* Hazslinszky, K. K. Zool.-bot. Ges. in Wien, Verhandl. **25**: 64–65. 1875; Magyar Tudományos Akad. Termeszettud. Közl. **13**: (9). 1875 (often cited as Magyarhon hasgombai, 9. 1876); Hedwigia **16**: 44. 1877; Saccardo, Syll. Fung. **11**: 172. 1895.

Illustrations: Hazslinszky, K. K. Zool.-bot. Ges. in Wien, Verhandl. **25**: *pl. 3;* Hollós, Magyarország Földalatti Gombai *pl. 3, f. 34, 35, pl. 5, f. 33.*

Type: in Magyar Nemzeti Museum in Budapest (fide A. de Degen in litt.) not seen.

Fructifications globose to irregular by the coalescence of several fructifications, smooth with surface foveolate, 1–5 cm. in diameter, yellowish white, becoming fuscous; peridium thin, at first white and glistening, then ochroleucous, gelatinous to waxy; cavities subglobose to polyhedral, larger in the center of the fructification, filled at first, becoming empty; basidia pyriform, 4-spored, not in a distinct layer; spores sessile, spherical, ochraceous, blunt echinulate with thick yellow reticulations, gelatinous sheath smooth, 16–18 μ in diameter.

Under *Picea*, Bartfeld, Czechoslovakia. August.

From a study of Hazslinszky's material, Hollós thought *L. liosporus* was a synonym of this species. He did not see any of Hesse's material of *L. liosporus*, and we prefer to recognize both names until we have seen authentic material of both. The above description is a condensation of a translation from Hollós and should be used with caution, as Hollós seems to have conflated a description based on Hazslinszky's material with Hesse's description of *L. liosporus*. From the above description the present species seems more closely related to *Leucophlebs candida* Harkn.

LEUCOPHLEBS[1]

Leucophleps Harkness, Cal. Acad. Sci. Proc. Bot. III. **1**: 257–259. 1899; Fischer in Engler & Prantl, Die Nat. Pflanzenfam. I. **1****: 557. 1900; Saccardo & Sydow in Sacc. Syll. Fung. **16**: 251–252. 1902.—*Leucophlebs* Roumeguère, Rev. Myc. **22**: 83. 1900.

The type species of the genus is considered to be *Leucophlebs magnata* Harkness. Harkness did not definitely designate the type species but he probably had in mind *L. magnata*, for that species is followed by "gen. nov. et sp. nov.," while the other species which he included in the genus are followed by "sp. nov." only. The international rules do not cover this case, but canons 14 and 15 of the "American" code[2] and article 7g of the recom-

[1] Spelling corrected by Roumeguère, Rev. Myc. **22**: 83. 1900, in accordance with international rules.

[2] Nomenclature Commission of the Botanical Club of the American Association for the Advancement of Science. American code of botanical nomenclature. Torr. Bot. Club Bull. **34**: 167–178. 1907 (see p. 172–173).

mendations of the Committee on Nomenclature of the Botanical Society of America[1] both point to the adoption of this species as the type of this genus.

Fructifications globose to irregular, hypogaeous; columella, stipe, or sterile base none; peridium usually thin and fragile, simplex, white; gleba white or slightly yellowish; cavities filled with hyphae bearing spores terminally on short branches; septa thin, homogeneous; spores echinate or reticulate at maturity, surrounded by a gelatinous sheath, globose, resembling those of *Leucogaster*.

From our study of the young stages of *Leucogaster floccosus* Hesse (p. 390), it seems probable that eventually *Leucophlebs* will be recognized as the chlamydosporic condition of *Leucogaster*, or retained as a hypogaeous genus of the *Fungi Imperfecti*.

1. **Leucophlebs magnata** Harkness, Cal. Acad. Sci. Proc. Bot. III. **1**: 257-258. 1899; Roumeguère, Rev. Myc. **22**: 83. 1900; Saccardo & Sydow in Sacc. Syll. Fung. **16**: 252. 1902.

Illustrations: Harkness, Cal. Acad. Sci. Proc. Bot. III. **1**: *pl. 42. f. 7a–7c;* Rev. Myc. **22**: *pl. 204. f. 6–8.*

Type: cotype in Dudley Herb. at Leland Stanford Jr. Univ.

Fructification 3 cm. in diameter, subglobose or elongate, white, smooth; peridium 120–150 μ thick, composed of fine, thick-walled, closely woven hyphae, white; gleba white, the freshly cut surface showing a blue tint which soon vanishes; cavities decreasing in size toward the surface, full of cobwebby hyphae like a capillitium; septa thin, homogeneous, 60–80 μ thick, composed of closely woven, hyaline hyphae; spores borne terminally on long slender branches of the cavity hyphae, hyaline, spherical, echinate, enclosed in a gelatinous sheath, 13 μ in diameter.

Under *Acer* and *Quercus*. Oregon to California. April and May.

In Harkness, 100b, crystalline matter is found in the peridium and in Harkness, 154b, the spores become quite thick-walled. The spines on the spores are arranged in rows, giving the appearance shown by Harkness (*l.c.*, *f. 7c*) when not quite in focus.

Specimens examined:

[1] Committee on Nomenclature of the Botanical Society of America. Report. Bot. Soc. Am. Publ. **73**: 70–71. 1919 (see p. 71).

Oregon: Corvallis, *L. M. Boozer* (in Oregon Agr. Coll. Herb. 4831, 4832, and Zeller Herb. 2323, 2324, and in Dodge Herb. 2073, 2074).

California: *H. W. Harkness, 100b, 154b;* Napa County, Calistoga, *H. W. Harkness, 154,* cotype (all in Dudley Herb. at Leland Stanford Jr. Univ.).

2. Leucophlebs candida Harkness, Cal. Acad. Sci. Proc. Bot. III. **1**: 258. 1899; Roumeguère, Rev. Myc. **22**: 83. 1900; Saccardo & Sydow in Sacc. Syll. Fung. **16**: 252. 1902.

Type: cotype in Dudley Herb. at Leland Stanford Jr. Univ.

Fructifications 2 cm. in diameter, irregular, white, surface studded with shallow depressions; peridium 15–20 μ thick, homogeneous with the septa; gleba white, becoming yellowish in alcohol; cavities filled with branched hyphae which bear spores terminally on the branches; septa thin; spores hyaline, spherical, reticulate at maturity, enclosed in a gelatinous sheath, 8 μ in diameter.

California. June.

The cotype of this species is so badly parasitized that its structure is very difficult to make out.

Specimens examined:

California: Marin County, Mill Valley, *H. W. Harkness, 207,* cotype (in Dudley Herb. at Leland Stanford Jr. Univ.).

3. Hydnangium liospermum Tulasne, Fung. Hypog. 76. 1851; DeToni in Saccardo, Syll. Fung. **7**: 176. 1888; Hesse, Hypog. Deutschl. **1**: 84. 1891.—*Octaviania liosperma* Lloyd, Myc. Notes **67**: 1141. 1923.

Illustrations: Tulasne, Fung. Hypog. *pl. 21. f. 1.*

Type: location unknown to us.

Fructification small (size of a pea), firm, globose, white, with a slight, sterile base, here and there enveloped in a white floccose mycelium separating in places; peridium thick, homogeneous, not separable, white, continuous with the septa; gleba firm, light ochraceous to apricot color; cavities unequal in size, narrow-oblong, radiating from the center to the periphery; septa mucous-cartilaginous, gray, hyaline by transmitted light, variable in

thickness, some arising from the base much thicker than others, homogeneous, of large, closely woven hyphae; spores borne terminally, mostly on 2-celled branches, globose, small, 6.5 μ in diameter, smooth, thick-walled.

Under fallen leaves in oak woods, almost epigaeous. Not far from Orleans (Parc de Beauvoir near Brivodurum). Autumn.

Hesse referred here a specimen in the Danziger Museum collected by Bail in Kreis Schwetz near Teufelsstein, October, 1878. From the above description it seems quite likely that this species is to be referred to *Leucophlebs*, where the small spores, yellow gleba, radiating elongated cavities, and rudimentary columella should serve to distinguish it from other members of this genus. However, we prefer not to make the transfer until we have the opportunity to study authentic material.

Explanation of Plate

PLATE 11

Fig. 1. *Leucogaster rubescens* Zeller & Dodge.

a. Section of peridium and septa showing pseudoparenchyma of the peridium, sections of fibrils on the surface, and the 4-spored basidia. Young material, × 150.

b. Young and mature basidium and spores, × 500.

c. Basidiospore showing the echino-reticulate character of the surface with gelatinous sheath, × 750.

Fig. 2. *Leucogaster araneosus* Zeller & Dodge.

a. Section of fibrous peridium and relation of septa showing the 4-spored basidia. Young material, × 150.

b. Basidia, × 500.

c. Basidiospore showing the alveolate-reticulate character of the surface, with blunt spines projecting from the angles of the alveoli and gelatinous sheath, × 1000.

Fig. 3. *Leucogaster luteomaculatus* Zeller & Dodge.

a. Section showing the duplex character of the peridium (the outer partly sloughed off), the scissile septum and basidia, × 150.

b. Basidia, × 500.

c. Basidiospore showing the verrucose character of the surface with gelatinous sheath, × 1000.

Fig. 4. *Leucogaster fulvimaculosus* Zeller & Dodge.

a. Section showing the thick peridium, with portion of fibril on surface, septa, definite layer of basidial stalks embedded in a gelatinous layer within the cavities and the basidiospores lining the cavities, × 150.

b. Basidia showing the typical 3-spored tips, × 500.

c. Basidiospore showing the simple reticulate surface with gelatinous sheath, × 750.

Fig. 5. Basidiospore of *Leucogaster odoratus* (Harkn.) Zeller & Dodge, × 750.

Fig. 6. Basidiospore of *Leucogaster foveolatus* (Harkn.) Zeller & Dodge, × 750.

Fig. 7. Basidiospores of *Leucogaster citrinus* (Harkn.) Zeller & Dodge.

a. Mature spore, × 750.

b. Young spore, × 750.

Fig. 8. Basidiospore of *Leucogaster anomalus* (Peck) Zeller & Dodge, showing the pitted surface, × 750.

Fig. 9. Basidiospore of *Leucogaster badius* Matt. showing the pitted surface, × 750.

Fig. 10. Basidiospore of *Leucogaster floccosus* Hesse, showing the echinulate-reticulate character of the exospore and thick gelatinous sheath, × 750.

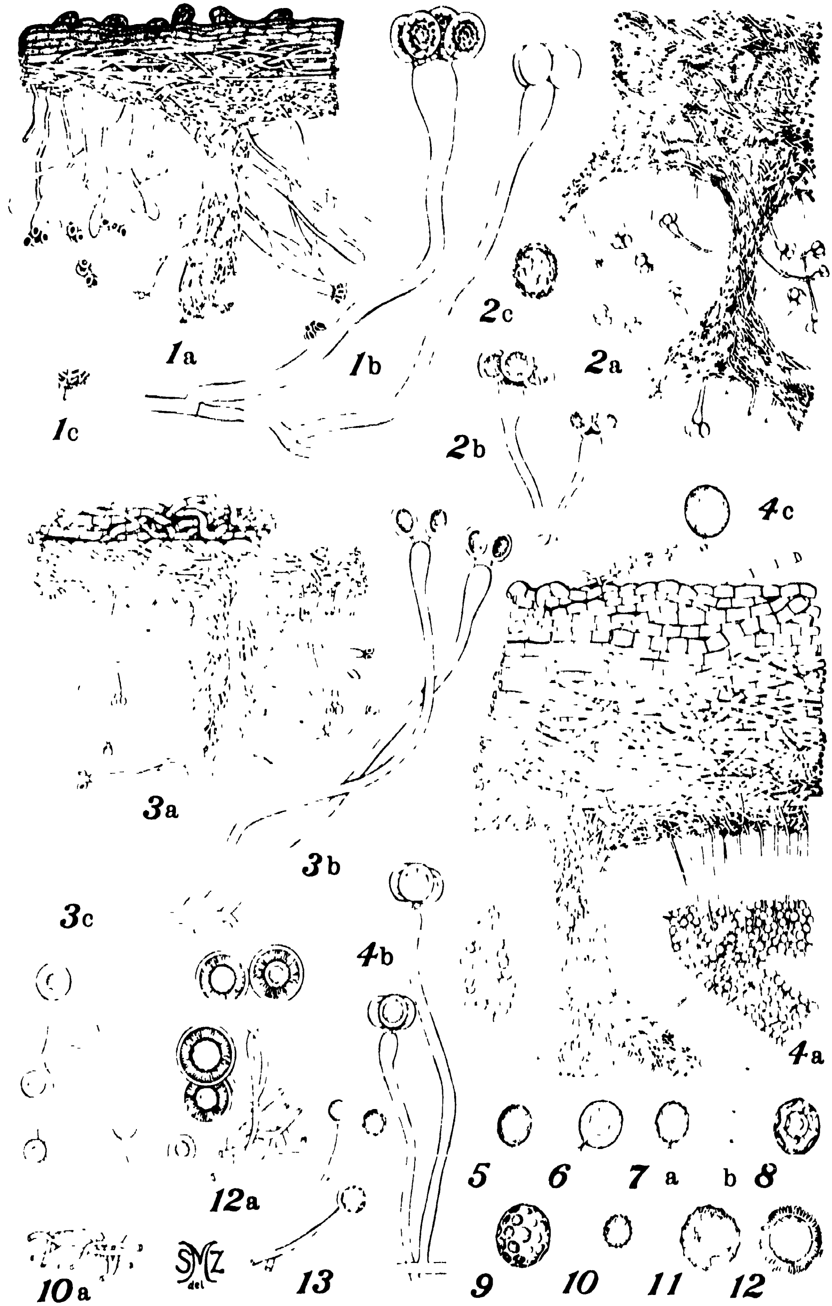
Fig. 10a. The conidia from young cavities of *Leucogaster floccosus*. This conidial stage cannot be distinguished from *Leucophlebs* Harkness, × 500.

Fig. 11. Basidiospore of *Leucogaster Tozziana* (Cav. & Sacc.) Matt., × 750.

Fig. 12. Conidium of *Leucophlebs magnata* Harkn. showing the peculiar markings in median view, × 750.

Fig. 12a. Shows the conidia and conidiophores of *L. magnata*, × 500.

Fig. 13. Conidia and conidiophores of *Leucophlebs candida* Harkn., × 500.



ZELLER AND DODGE—LEUCOGASTER AND LEUCOPHLEBS

VARIATION AND CORRELATION IN THE INFLORESCENCE OF MANFREDA VIRGINICA

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I. Introduction

The purpose of this paper, which is one of a series on the general problem of the physiology of fertility in plants, is to present the results of a biometric study of variation and correlation in the inflorescences of *Manfreda virginica.*

This study was planned, the materials collected, and practically all the tabulations made at the Missouri Botanical Garden in 1906 and 1907.[1] The calculations were, in large part, carried out in the Biometric Laboratory at University College, London, in 1908. The long delay in completing the manuscript for publication has been in part due to pressure of other work and in part to an effort to secure formulae to deal more effectively with certain phases of the problem.

The points to be especially considered are:—

1. The variability and correlation of the same species when growing in different habitats.
2. The correlation between the number of flowers produced and the number of capsules developing, and between the number of flowers and capsules produced and the number of seeds developing.
3. The relationship between position of the flower on the inflorescence and fruit production.
4. The correlation between position of the flower on the inflorescence and the number of seeds per locule and per fruit.
5. The correlation between the position of the fruit on the inflorescence and the number of seeds per locule and per fruit.
6. The correlation between the number of seeds in the 3 locules of the fruit.

[1] The initial stages of the work were aided by a grant from the American Association for the Advancement of Science.

II. MATERIALS

The inflorescence of *M. virginica* is a favorable subject for work on the problem of fertility. Since all the flowers are arranged on a single axis, it is easy to consider the influence of position on the inflorescence upon the chances of development of the fruit and upon the characteristics of the matured fruit. The flowers which fail to produce fruits leave a conspicuous scar, so that the number of flowers produced may be accurately determined. The ripened seeds have a fine black color and are easily counted. Unfortunately it is impossible to determine the number of ovules formed. The trimerous nature of the fruit makes possible the consideration of certain problems concerning the interrelationship of numbers of seeds per locule.

Collections of material were taken from 2 different localities. The first was the more open woods at Meramec Highlands, near St. Louis. The second was the edge of the limestone cliffs along the Mississippi River, south of Jefferson Barracks, Mo.

In the absence of quantitative criteria no attempt will be made to distinguish in any precise way between the conditions for plant growth in these 2 habitats. The general impression conveyed by an examination of the two habitats was that growth at Meramec Highlands was much more luxuriant than that on the crests of the cliffs south of Jefferson Barracks.

The countings made comprise the following:—

1. Number of flowers per inflorescence (f).
2. Number of capsules matured per inflorescence (c).
3. The actual position of the capsule on the inflorescence (p). This is the position of the flower measured from the proximal end of the inflorescence. Thus the position of the first flower is 1, while that of the terminal flower is measured by the number of flowers produced on the inflorescences.
4. Relative position of the capsule (r). This measures the position of the individual capsule in the series produced by an inflorescence. Thus the relative position of the lowermost capsule will be 1, whatever the position of the flower which produced it, while that of the most distal capsule will be the same as the number of capsules produced by the inflorescence in question.

5. Number of seeds per locule (*s*).

The symbols in parentheses are those used to designate the several characters in the formulae.

The heavy work of counting the number of seeds per locule was carried out in only 1100 inflorescences or 18774 locules. Number of flowers and number of capsules was determined in a larger number of inflorescences, 3425 in all.

For convenience of reference the series of material are designated as follows:—

I. Three hundred inflorescences, Meramec Highlands, 1906. Seeds counted.

II. Two hundred fifty inflorescences, below Jefferson Barracks, 1906. Seeds counted.

III. One thousand inflorescences, below Jefferson Barracks, 1906. Flowers and fruits only counted.

IV. Three hundred inflorescences, Meramec Highlands, 1907. Seeds counted.

V. Three hundred five inflorescences, Meramec Highlands, 1907. Flowers and fruits only counted.

VI. Two hundred fifty inflorescences, below Jefferson Barracks, 1907. Seeds counted.

VII. One thousand twenty inflorescences, below Jefferson Barracks, 1907. Flowers and fruits only counted.

In studies involving only the number of flowers and number of fruits per inflorescence series II and III can be treated together; series IV can be combined with series V; and series VI added to series VII for the purpose of securing larger and smoother distributions. In respect to these characters series IV and V and series VI and VII should show only the differences due to random sampling, since practically all the material for each of the pairs was taken at one time and a subsample was drawn at random for the seed countings.

The lot of material from the Jefferson Barracks locality for 1907 is not strictly comparable with that for 1906 in one respect. The plants from which the countings of the number of seeds per locule were made in 1906 were collected all along the bluffs from Jefferson Barracks to a point above Cliff Cave. In 1907 the material from which the countings of seed number were made was taken

TABLE I

FREQUENCY DISTRIBUTION OF NUMBER OF FLOWERS PER INFLORESCENCE WITH TOTAL NUMBER OF FRUITS AND SEEDS PRODUCED BY EACH CLASS OF INFLORESCENCE IN 4 SERIES IN WHICH NUMBER OF SEEDS PER LOCULE WAS DETERMINED

Flowers	J. B. 1906			J. B. 1907			M. H. 1906			M. H. 1907		
	f	Fruits	Seeds	f	Fruits	Seeds	f	Fruits	Seeds	f	Fruits	Seeds
2	1	1	47	—	—	—	—	—	—	—	—	—
6	1	2	58	—	—	—	—	—	—	—	—	—
7	1	4	148	—	—	—	—	—	—	1	1	43
8	—	—	—	—	—	—	—	—	—	1	2	73
9	1	2	67	—	—	—	1	2	82	1	1	27
10	—	—	—	1	7	85	—	—	—	—	—	—
11	2	6	193	—	—	—	—	—	—	1	7	66
12	3	8	220	—	—	—	1	3	154	—	—	—
13	1	2	56	2	4	138	2	6	163	4	13	291
14	7	20	593	5	13	452	2	5	147	—	—	—
15	8	21	664	2	6	323	1	4	156	6	21	769
16	9	29	960	6	24	807	2	7	221	7	21	917
17	15	37	1141	11	50	1681	4	14	658	6	21	778
18	12	43	1335	12	39	1511	6	26	1152	10	39	1640
19	17	60	1435	6	26	941	8	35	1505	16	59	2552
20	15	64	1676	11	43	1400	10	40	1452	12	47	1557
21	25	104	2764	6	24	686	14	59	2441	11	50	2012
22	18	79	2291	14	65	2389	10	42	1559	19	79	3279
23	12	51	1196	18	93	2918	7	36	1443	4	15	655
24	8	33	1077	14	68	2118	12	65	2612	13	73	2765
25	14	60	2003	15	82	2320	13	75	3071	15	79	2752
26	9	53	1469	11	62	2152	15	88	3722	16	86	3413
27	11	45	1654	14	74	2320	18	124	5353	16	83	2799
28	6	23	462	7	33	1067	17	103	4365	14	78	3339
29	7	37	878	5	30	1038	11	57	2399	13	80	2829
30	6	30	1234	7	44	1440	13	90	3819	9	60	2175
31	1	4	147	6	30	1026	18	128	5109	14	94	2942
32	6	37	1570	8	54	1852	6	42	1840	14	84	3419
33	4	22	767	9	61	1890	16	129	5237	7	47	1621
34	5	44	1628	9	65	2059	12	114	5059	13	92	3932
35	4	26	1084	12	77	2640	17	127	4510	10	83	3426
36	6	39	1584	5	28	938	9	73	2859	6	48	1536
37	2	16	462	6	51	1310	7	57	2343	6	47	1854
38	4	27	894	2	18	762	3	20	891	4	33	1292
39	1	7	263	4	28	903	5	41	1556	5	55	2152
40	1	8	345	3	17	607	6	50	2436	5	44	1715
41	1	10	227	3	25	684	3	31	1183	4	32	1134
42	1	11	355	3	25	938	7	70	3027	3	27	906
43	2	17	662	2	31	828	1	9	360	3	28	1113
44	—	—	—	3	17	609	2	13	510	4	32	1592
45	1	10	222	3	30	692	5	55	2345	1	8	428
46	—	—	—	3	32	1318	3	33	1251	1	13	453
47	1	16	454	1	10	356	1	9	256	—	—	—
48	—	—	—	—	—	—	5	47	2028	—	—	—
49	—	—	—	—	—	—	1	7	337	—	—	—
50	1	12	326	—	—	—	—	—	—	—	—	—
51	—	—	—	—	—	—	—	—	—	2	22	1188
52	—	—	—	—	—	—	—	—	—	—	—	—
53	—	—	—	—	—	—	1	12	388	1	13	465
54	—	—	—	—	—	—	3	41	2150	—	—	—
55	—	—	—	—	—	—	2	28	1178	—	—	—
60	—	—	—	1	6	195	—	—	—	—	—	—
61	—	—	—	—	—	—	—	—	—	2	20	655

entirely from the vicinity of Cliff Cave. The 1000 stalks taken in 1906 for countings of flowers and fruits only and the entire series of 1270 inflorescences taken in 1907 are therefore directly comparable as samples of the same species from the same locality for 2 years.

III. Presentation and Analysis of Data

I. TYPE AND VARIATION IN DIFFERENT HABITATS

In this section we have to consider the frequency distributions of number of flowers and fruits per inflorescence, and the number of seeds matured per locule and per fruit.

In doing this we shall hope to replace the impression of chaotic disorder which must be the result of mere inspection in the field by a definite mental picture of the orderliness which prevails in the frequencies of the numbers of flowers and fruits, in the position of insertion of the fruits, and in the number of seeds per locule and per fruit.

The frequency distribution of number of flowers per inflorescence in the 4 series in which the number of seeds was determined is shown in table I.[1] For the 3 other series, in which flowers and fruits only were counted, the reader must consult table II.

Because of the wide range of variation in number of flowers per inflorescence, very irregular graphs are obtained if the ungrouped frequencies are plotted. Grouping in classes of 3-units range and reducing to percentage frequencies we have the distributions for the two habitats represented in fig. 1 for 1906 and in fig. 2 for 1907. In 1906 the results for Meramec Highlands (N = 300) and Jefferson Barracks (N = 1250) are not in good agreement. The distribution for Meramec Highlands is particularly irregular, but this is doubtless due in large part to the fact that this series comprises only 300 inflorescences—less than one quarter the number from Jefferson Barracks. In 1907 the distributions represent 605 inflorescences for Meramec Highlands and 1270 for Jefferson Barracks, and are in much closer agreement.

[1] The frequencies of inflorescences with varying numbers of flowers are alone required here. The total fruits and total seeds which are also given will be used for the determination of correlations in a subsequent section.

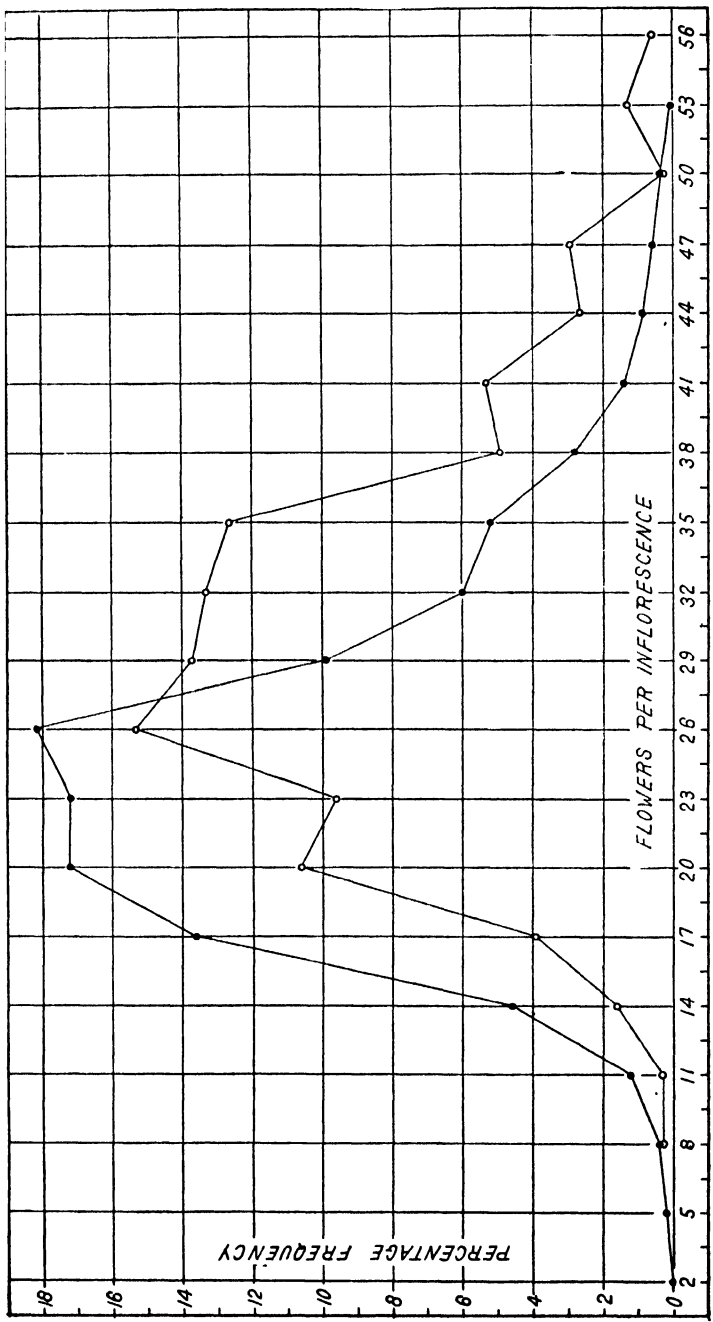

Fig. 1. Percentage frequency distribution of number of flowers per inflorescence in 2 habitats in 1906. Circles = Meramec Highlands, solid dots = Jefferson Barracks.

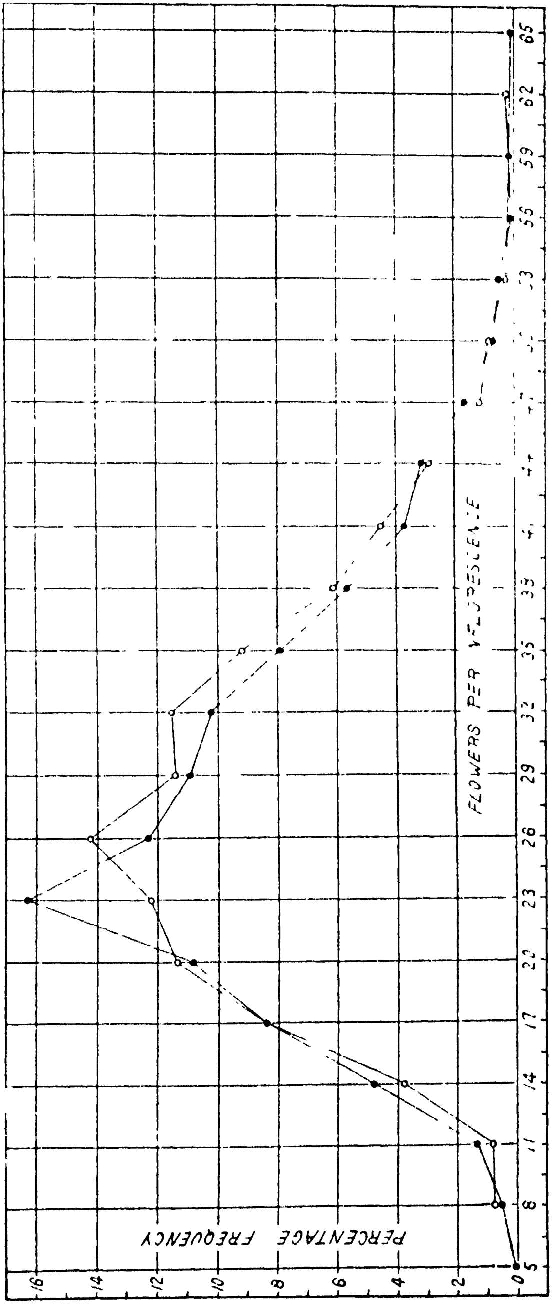

Fig. 2. Percentage frequency distribution of number of flowers per inflorescence in 2 habitats in 1907. Circles = Meramec Highlands solid dots = Jefferson Barracks.

TABLE II

FREQUENCY DISTRIBUTION OF NUMBER OF FLOWERS PER INFLORESCENCE AND TOTAL NUMBER OF FRUITS ON EACH CLASS OF INFLORESCENCE IN 3 SERIES IN WHICH FLOWERS AND FRUITS ONLY WERE COUNTED

Flowers	J. B. 1906		J. B. 1907		M. H. 1907	
	f	Fruits	f	Fruits	f	Fruits
4	1	2	—	—	—	—
6	—	—	1	2	—	—
7	2	4	2	5	—	—
8	—	—	1	2	—	—
9	1	1	4	11	1	2
10	1	2	2	2	—	—
11	5	13	4	12	2	6
12	3	8	9	26	2	4
13	11	31	18	50	2	6
14	14	39	19	70	5	15
15	17	49	15	51	6	15
16	42	140	30	116	8	34
17	43	160	22	87	5	20
18	49	190	26	108	15	56
19	53	209	39	167	7	33
20	51	208	39	170	10	47
21	54	239	37	162	12	48
22	59	262	66	340	16	78
23	54	258	52	246	5	28
24	64	327	43	227	17	86
25	58	312	46	276	14	72
26	58	364	30	172	18	105
27	78	415	40	248	7	39
28	36	226	46	285	13	72
29	36	260	43	296	10	51
30	33	219	31	212	10	69
31	24	180	36	302	14	94
32	23	156	30	218	10	66
33	17	111	41	290	11	71
34	19	146	25	204	16	106
35	16	117	23	184	6	46
36	15	111	27	236	5	42
37	9	69	23	190	7	48
38	10	99	16	146	10	75
39	9	87	22	196	5	42
40	6	48	11	99	7	69
41	5	48	13	131	6	52
42	4	36	15	137	2	22
43	3	31	10	115	4	35
44	2	9	11	113	2	22
45	3	32	12	131	4	21
46	5	54	9	92	1	18
47	—	—	4	50	2	21
48	2	23	7	100	3	44
49	—	—	3	43	3	36
50	2	23	3	31	—	—
51	2	32	3	34	—	—
52	—	—	4	46	—	—
53	—	—	2	22	1	20
54	1	11	1	14	—	—
56	—	—	1	12	—	—
57	—	—	1	19	—	—
58	—	—	—	—	—	—
59	—	—	1	9	1	13
66	—	—	1	27	—	—

TABLE III

STATISTICAL CONSTANTS FOR NUMBER OF FLOWERS PER INFLORESCENCE

Series	N	Mean	Standard deviation	Coefficient of variation
Meramec Highlands 1906 (I)	300	29.9467±.3301	8.4859±.2337	28.3367±0.8406
Meramec Highlands 1907 (IV)	300	27.6100±.3294	8.4592±.2330	30.6381±0.9195
Meramec Highlands 1907 (V)	305	28.2721±.3441	8.9098±.2433	31.5144±0.9422
Meramec Highlands 1907 (IV)+(V)	605	27.9438±.2384	8.6956±.1686	31.1181±0.6592
Jefferson Barracks 1906 (II)	250	23.4760±.3196	7.4929±.2260	31.9172±1.0561
Jefferson Barracks 1906 (III)	1000	24.7480±.1502	7.0461±.1062	28.4716±0.4628
Jefferson Barracks 1906 (II)+(III)	1250	24.4936±.1365	7.1558±.0965	29.2148±0.4260
Jefferson Barracks 1907 (VI)	250	27.2360±.3519	8.2479±.2488	30.2832±0.9935
Jefferson Barracks 1907 (VII)	1020	27.6078±.1943	9.2020±.1373	33.3312±0.5500
Jefferson Barracks 1907 (VI)+(VII)	1270	27.5346±.1708	9.0234±.1207	32.7711±0.4832

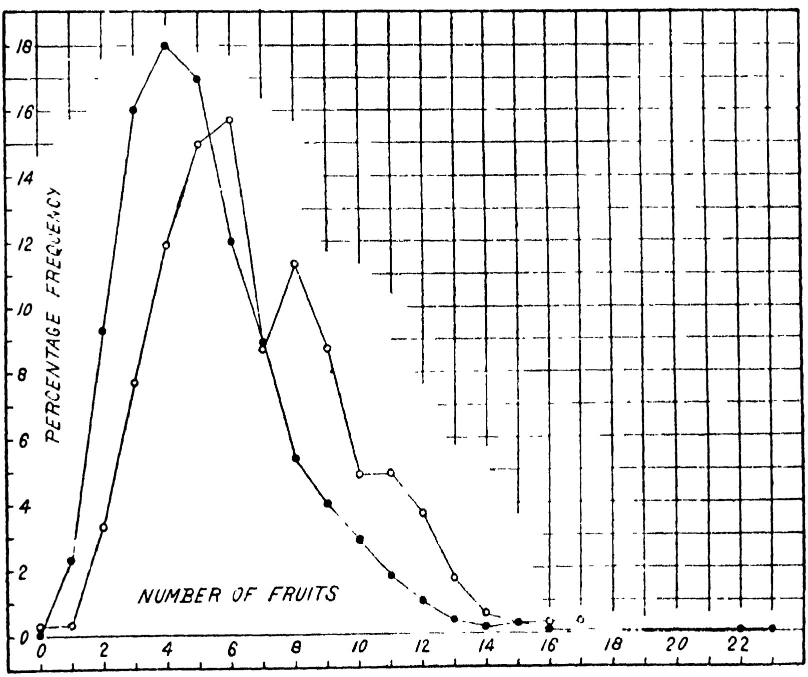

Fig. 3. Percentage frequency distribution of number of fruits per inflorescence in 2 habitats in 1906. Circles = Meramec Highlands, solid dots = Jefferson Barracks.

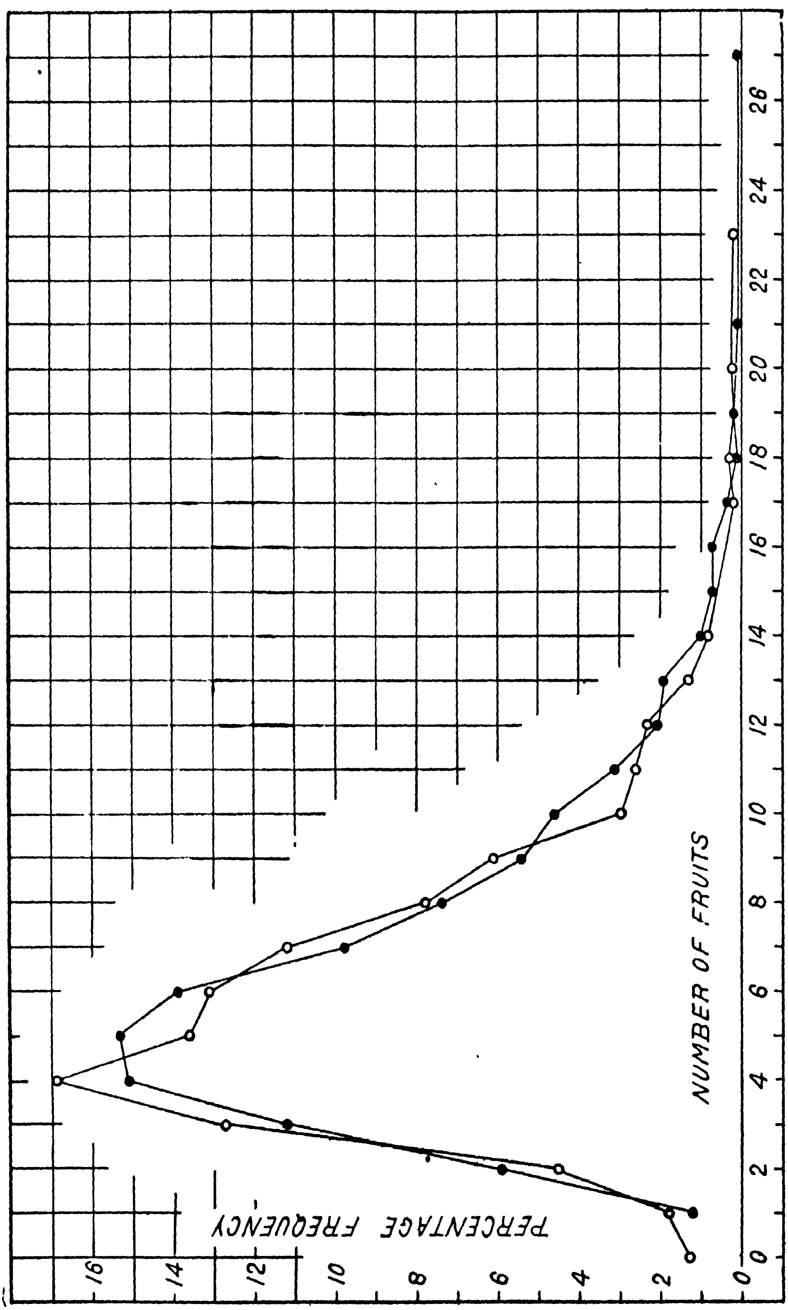

Fig. 4. Percentage frequency distribution of number of fruits per inflorescence in 2 habitats in 1907. Circles = Meramec Highlands. solid dots = Jefferson Barracks.

The fundamental variation constants, means, standard deviations and coefficients of variation of number of flowers per inflorescence in the several series of materials appear in table III. These will be discussed in comparison with those for number of fruits per inflorescence.

The frequency distribution of number of fruits per inflorescence in the 7 series of materials is shown in table IV. Series I, II + III, IV + V, and VI + VII have been reduced to percentage frequencies and are represented graphically in fig. 3 for 1906 and fig. 4 for 1907.

With the exception of the Meramec Highlands series for 1906, in which the number of observations is only 300, the frequencies

TABLE IV

FREQUENCY DISTRIBUTIONS OF NUMBER OF FRUITS PER INFLORESCENCE IN 7 SERIES AND TOTAL SEEDS PRODUCED ON EACH CLASS OF INFLORESCENCE IN 4 SERIES IN WHICH NUMBER OF SEEDS WAS DETERMINED

Fruits	J. B. 1906 II		J. B. 1907 VI		M. H. 1906 I		M. H. 1907 IV		Series III	Series VII	Series V
	f	Seeds	f	Seeds	f	Seeds	f	Seeds	f	f	f
0	—	—	—	—	—	—	—	—	—	—	5
1	14	428	5	171	1	17	7	348	15	10	4
2	68	2427	28	957	20	985	24	991	82	61	15
3	165	5317	111	4367	69	3033	120	5138	145	105	37
4	184	5807	172	5682	144	5941	208	8521	179	149	50
5	155	4834	210	7198	225	9183	180	7399	183	152	46
6	126	4130	210	7128	282	12503	264	9620	129	141	35
7	105	2974	196	6184	183	7565	231	8067	96	96	35
8	96	3282	112	3255	272	10818	200	7229	55	80	22
9	54	1341	90	2525	234	9317	171	6727	44	59	18
10	80	2060	70	2497	150	6612	100	3616	28	51	8
11	33	991	66	2115	165	6658	44	1505	20	34	12
12	24	566	48	1329	132	4960	108	4239	10	22	5
13	--	—	26	685	65	2605	52	2028	5	22	4
14	—	—	14	579	28	1087	28	1126	2	11	3
15	—	—	—	—	15	621	—	—	4	9	—
16	16	454	16	328	16	641	—	—	1	8	—
17	—	—	—	—	16	781	—	—	—	4	1
18	—	—	18	398	—	—	—	—	—	1	2
19	—	—	—	—	—	—	—	—	—	3	1
20	—	—	—	—	—	—	—	—	—	—	1
21	—	—	—	—	—	—	—	—	—	1	—
22	—	—	—	—	—	—	—	—	1	—	—
23	—	—	—	—	—	—	—	—	1	—	1
24	—	—	—	—	—	—	—	—	—	—	—
25	—	—	—	—	—	—	—	—	—	—	—
26	—	—	—	—	—	—	—	—	—	—	—
27	—	—	—	—	—	—	—	—	—	1	—

form very smooth distributions. In all, a conspicuous skewness, a tendency to tail off in the direction of the larger number of fruits, is a characteristic feature.

The physical constants for number of fruits per inflorescence are shown for all the series in table v.

The first question concerning the statistical constants of both flowers and fruits which requires consideration is that of the difference between the means of the series for the different years in the same habitat and for the different habitats. The comparisons may be based upon the combination series in so far as these are

TABLE V

STATISTICAL CONSTANTS FOR NUMBER OF FRUITS PER INFLORESCENCE

Series	N	Mean	Standard deviation	Coefficient of variation
Meramec Highlands 1906 (I)	300	6.7233±.1134	2.9109±.0802	43.2958±1.3980
Meramec Highlands 1907 (IV)	300	5.7900±.1073	2.7554±.0759	47.5900±1.5798
Meramec Highlands 1907 (V)	305	6.0623±.1297	3.3593±.0917	55.4123±1.9226
Meramec Highlands 1907 (IV)+(V)	605	5.9273±.0843	3.0777±.0596	51.9247±1.2490
Jefferson Barracks 1906 (II)	250	4.4800±.1076	2.5222±.0761	56.2995±2.1704
Jefferson Barracks 1906 (III)	1000	5.3610±.1143	2.6162±.0808	48.8012±0.8941
Jefferson Barracks 1906 (II)+(III)	1250	5.1848±.0500	2.6215±.0353	50.5611±0.8378
Jefferson Barracks 1907 (VI)	250	5.5680±.1156	2.7095±.0817	48.6619±1.7815
Jefferson Barracks 1907 (VII)	1020	6.4059±.0701	3.3237±.0496	51.8852±0.9608
Jefferson Barracks 1907 (VI)+(VII)	1270	6.2409±.0611	3.2293±.0432	51.7442±0.8579

TABLE VI

COMPARISON OF THE STATISTICAL CONSTANTS FOR THE 2 DIFFERENT YEARS FOR PLANTS GROWING IN THE SAME HABITAT

Difference 1906 less 1907	Mean	Standard deviation	Coefficient of variation
Meramec Highlands			
Flowers	+2.0029±.4074	−0.2097±.2882	−2.7814±1.0682
Fruits	+0.7960±.1413	−0.1668±.0999	−8.6289±1.8747
Jefferson Barracks			
Flowers	−3.0410±.2186	−1.8676±.1545	−3.5563±0.6442
Fruits	−1.0561±.0790	−0.6078±.0558	−1.1831±1.1991

available. Thus in comparing the results for the 2 years in the same habitat we may determine the differences between the means for series I and series IV + V for Meramec Highlands and for series II + III and series VI + VII for Jefferson Barracks. The differences for the two years are given in table VI, which shows that the average number of flowers and fruits is slightly, but significantly, higher at Meramec Highlands in 1906 than in 1907, whereas the reverse is true at Jefferson Barracks. The variabilities, both absolute (S. D.) and relative (C. V.) are higher for both flowers and fruits in both habitats in 1907 than in 1906.

We now have to consider the difference in the infloresсsence produced in the 2 habitats in the same year. The differences may be taken (Meramec Highlands) less (Jefferson Barracks).

The differences in table VII are obtained by comparing the results for series I (Meramec Highlands) and series II + III (Jefferson Barracks) for 1906, and for series IV + V (Meramec Highlands) and series VI + VII (Jefferson Barracks) for 1907. The differences in this table show that in both years the number

TABLE VII

COMPARISON OF THE STATISTICAL CONSTANTS FOR PLANTS GROWING IN THE DIFFERENT HABITATS IN THE SAME YEAR

Difference	Mean	Standard deviation	Coefficient of variation
1906			
Flowers	$+5.4531\pm.3575$	$+1.3301\pm.2528$	-0.8781 ± 0.9424
Fruits	$+1.5385\pm.1239$	$+0.2894\pm.0876$	-7.2653 ± 1.6298
1907			
Flowers	$+0.4092\pm.2933$	$-0.3278\pm.2074$	-1.6530 ± 0.8173
Fruits	$-0.3136\pm.1041$	$-0.1516\pm.0736$	$+0.1805\pm1.5153$

of flowers is larger at Meramec Highlands than at Jefferson Barracks. The difference in 1907 is, however, insignificant. The number of fruits is slightly higher at Meramec Highlands in 1906 but slightly lower in 1907. The results of this comparison show that the differences between the 2 habitats are either nil or much smaller than would have been anticipated from a mere inspection of the 2 habitats.

We now turn to the question of relative values of the constants for number of flowers and number of fruits per inflorescence.

Comparing the mean number of flowers and fruits as given in tables III and V, we note that the average flower number ranges from 23.5 to 29.9, whereas the mean number of fruits range from 4.5 to 6.7. Thus only about 20 per cent of the flowers develop into fruits.

We also require some measure of the relative fruit production of the several series.

For this purpose we may make use of the coefficient of fecundity (Harris, '10), i. e., the ratio $\bar{c}/\bar{f}$.[1]

The coefficients are given in table VIII, which shows that about 22 per cent of the flowers develop into fruits. The probable errors are low, and the differences between the several series are

TABLE VIII

COEFFICIENTS OF FECUNDITY IN THE 4 SERIES

Series	Number of inflorescences	Coefficient of fecundity
Meramec Highlands 1906	300	$.2245 \pm .0030$
Meramec Highlands 1907	605	$.2121 \pm .0021$
Jefferson Barracks 1906	1250	$.2117 \pm .0016$
Jefferson Barracks 1907	1270	$.2267 \pm .0015$

possibly significant in comparison with their probable errors. The actual magnitude of the differences is, however, very small, being $.0124 \pm .004$ for the 2 Meramec Highlands series, $.0150 \pm .002$ for the 2 Jefferson Barracks series, $.0128 \pm .003$ for the series from the 2 habitats in 1906, and $.0146 \pm .003$ for the series from the 2 habitats in 1907.

The standard deviations as given in tables III and V for number of flowers range from 7.0 to 9.2, whereas those for number of fruits vary from 2.5 to 3.4 in the several series. The significance of the differences between the several lots of material has been discussed above. The absolute variability (standard deviation) of number of fruits per inflorescence is much smaller than that for number of flowers per inflorescence. In general the fruits are about one-third the comparable values for the flowers.

[1] The probable error of C. F., the coefficient of fecundity, is given by

$$.67449 \sqrt{c \times (1 - c/f)}/f.$$

The great difference in the mean number of flowers and fruits renders a discussion of the comparison of variability impossible except on the basis of constants involving correction for mean numbers. These constants are afforded by the coefficients of variation which show that the variation for number of fruits per inflorescence is regularly higher than that for number of flowers per inflorescence. The coefficients of variation for number of flowers range from 28.3 to 33.3, whereas those for number of fruits range from 43.3 to 56.3.

This result for relative variability in flower and fruit number is substantiated by results for *Crinum longifolium* and *Celastrus scandens*, but not for *Staphylea trifolia*. The actual coefficients are as follows:

	Flowers	Fruits
Crinum longifolium (Harris, 1912 a)	22.80–24.32	31.73–33.70
Celastrus scandens (Harris, 1909)	26.80	48.58
Staphylea trifolia (Harris, 1909 a)	64.44	53.04

In a series of inflorescences of varying numbers of flowers per inflorescence the distribution of the position of the flowers on the inflorescence must be considered in relation to the number of flowers in each position, the ovaries of which might have developed into capsules.

Table IX shows the number of flowers formed and the number of capsules matured in the various positions on the inflorescence for 3 of the series of data.[1] From these data the percentage frequencies of numbers of capsules matured in each position on the inflorescence have been derived and are represented in fig. 5. The higher positions, of course, occur only on the larger inflorescences. In any sample which it is practicable to secure, the numbers of flowers and fruits in the more distal positions are so small that percentages calculated upon them are very irregular. Only percentages based upon at least 100 flowers have been included in the diagram.

[1] The reader who cares to do so may determine the number of flowers and number of fruits for the 3 series of inflorescences in which number of flowers and number of fruits only was determined by subtracting the appropriate sections of table X from table IX.

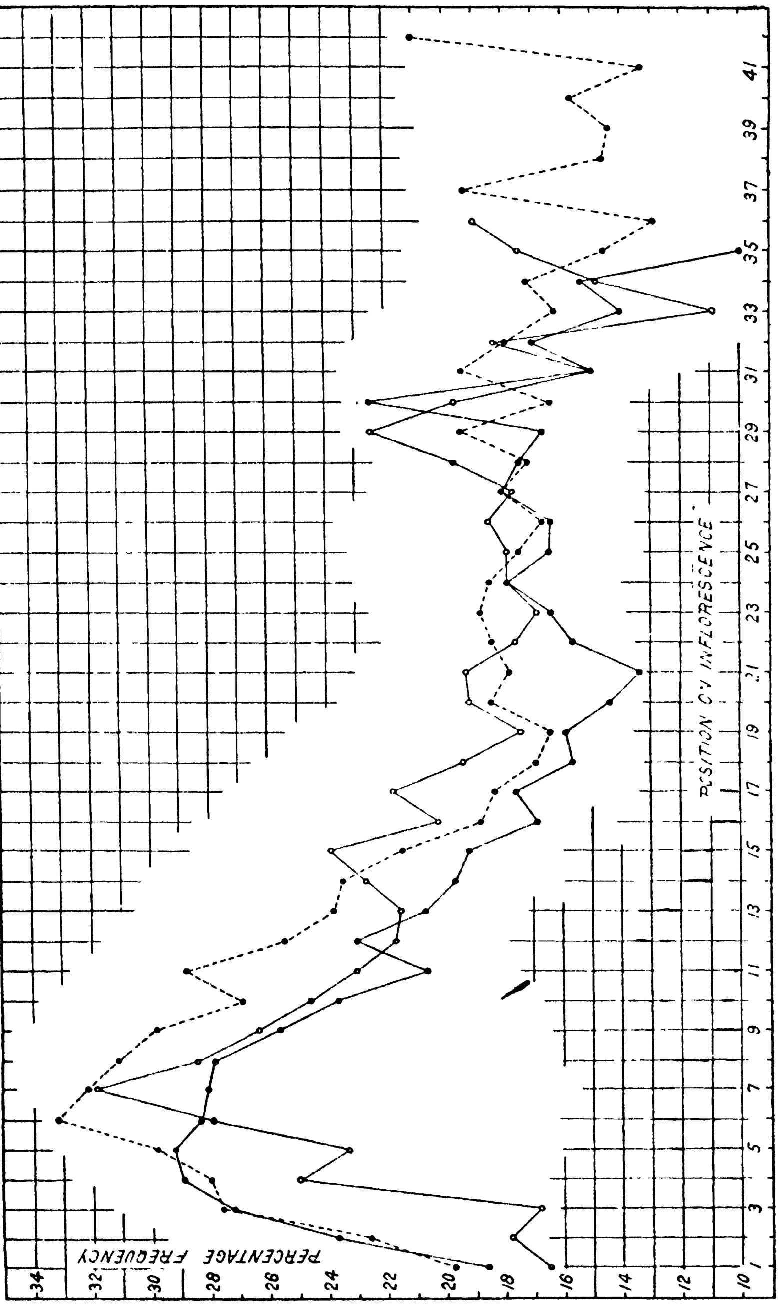

Fig. 5 Percentage frequencies of flowers which develop into fruits in various positions on the inflorescence. Circles and solid lines = Meramec Highlands, 1907; solid dots and solid lines = Jefferson Barracks, 1906; solid dots and broken lines = Jefferson Barracks, 1907.

The 3 series of countings represented in the diagrams show essential agreement in that the relative number of capsules developing in the most proximal position is low. It increases rapidly to a maximum on about the sixth position. It then declines rapidly to about 17 per cent in the twentieth position, after which it remains about the same throughout the remainder of the inflorescence.[1]

TABLE IX

NUMBER OF FLOWERS AND FRUITS PRODUCED AT VARIOUS POSITIONS ON THE INFLORESCENCE IN 3 SERIES IN WHICH FLOWERS AND FRUITS ONLY WERE COUNTED

P	J. B. 1906		J. B. 1907		M. H. 1907		P	J. B. 1906		J. B. 1907		M. H. 1907	
	Fl.	Fr.	Fl.	Fr.	Fl.	Fr.		Fl.	Fr.	Fl.	Fr.	Fl.	Fr.
1	1250	233	1270	251	605	100	34	143	22	308	53	155	23
2	1250	297	1270	287	605	108	35	119	12	274	40	126	22
3	1249	340	1270	351	605	102	36	99	18	239	31	110	21
4	1249	362	1270	356	605	152	37	78	12	207	10	99	13
5	1248	364	1270	379	605	141	38	67	15	178	26	86	15
6	1248	354	1270	422	605	169	39	53	12	160	23	72	13
7	1247	351	1269	409	605	193	40	43	6	134	21	62	12
8	1244	348	1267	395	604	172	41	36	5	120	16	50	10
9	1244	320	1266	378	603	159	42	30	8	104	22	40	10
10	1242	294	1262	339	601	148	43	25	6	86	18	35	7
11	1241	256	1259	361	601	139	44	20	5	74	12	28	9
12	1234	285	1255	321	598	130	45	18	1	60	12	21	5
13	1228	255	1246	297	596	128	46	14	3	44	4	18	5
14	1216	240	1226	288	590	134	47	9	—	33	5	15	2
15	1195	229	1202	259	585	140	48	8	1	28	5	13	3
16	1170	198	1185	223	573	116	49	6	—	21	2	10	2
17	1119	197	1149	210	558	122	50	6	—	18	2	7	—
18	1061	167	1116	189	547	106	51	3	—	15	2	7	1
19	1000	159	1078	177	522	91	52	1	—	12	1	5	3
20	930	134	1033	190	499	96	53	1	—	8	—	5	—
21	864	116	985	176	477	92	54	1	—	6	1	3	—
22	785	124	939	173	454	80	55	—	—	5	—	3	—
23	708	116	861	162	419	71	56	—	—	5	—	3	—
24	642	115	790	146	410	73	57	—	—	4	—	3	1
25	570	94	732	128	380	68	58	—	—	3	—	3	1
26	498	82	672	112	351	65	59	—	—	3	—	3	2
27	431	78	631	114	317	56	60	—	—	2	—	2	—
28	342	60	577	99	294	58	61	—	—	1	—	—	—
29	300	50	524	102	267	60	62	—	—	1	—	—	—
30	257	58	476	78	244	48	63	—	—	1	1	—	—
31	218	33	438	85	225	34	64	—	—	1	1	—	—
32	193	33	396	71	197	36	65	—	—	1	1	—	—
33	164	23	358	58	173	19	66	—	—	1	1	—	—

[1] There may be a secondary node at about the 29th to the 30th position. Possibly this is due to the fact that such positions are found only on the larger inflorescences.

TABLE X

NUMBERS OF FLOWERS, FRUITS AND SEEDS AT VARIOUS POSITIONS ON THE INFLORESCENCE IN 4 SERIES IN WHICH NUMBER OF SEEDS WAS DETERMINED

P	J. B. 1906			J. B. 1907			M. H. 1906			M. H. 1907		
	Fl.	Fr.	S.	Fl.	Fr.	S.	Fl.	Fr.	S.	Fl.	Fr.	S.
1	250	31	1062	250	39	1416	300	60	2585	300	58	2187
2	250	40	1269	250	49	1777	300	75	3032	300	56	2151
3	249	44	1715	250	58	2023	300	87	3660	300	55	2087
4	249	57	2130	250	70	2537	300	93	4044	300	77	3035
5	249	48	1605	250	71	2391	300	86	3483	300	75	2969
6	249	49	1801	250	73	2487	300	97	4251	300	90	3794
7	248	48	1376	250	68	2466	300	82	3569	300	94	3722
8	247	52	1687	250	85	2708	300	72	2876	299	82	3468
9	247	52	1639	250	85	3051	300	77	3444	298	79	3187
10	246	43	1501	250	63	2049	299	75	2991	297	72	2932
11	246	37	1121	249	70	2173	299	76	3263	297	68	3041
12	244	53	1717	249	60	1795	299	62	2733	296	72	2595
13	241	53	1460	249	45	1532	298	65	2566	296	59	2301
14	240	53	1332	247	49	1564	296	66	2886	292	61	2411
15	233	40	1121	242	42	1345	294	67	2937	292	66	2804
16	225	40	1254	240	47	1626	293	71	3064	286	56	2192
17	216	52	1182	234	30	1003	291	65	2532	279	56	2251
18	201	45	1389	223	34	1117	287	55	2590	273	55	1911
19	189	40	1172	211	37	1222	281	62	2691	263	49	1697
20	172	30	808	205	35	1099	273	60	2488	247	43	1558
21	157	22	779	194	28	727	263	40	1569	235	39	1363
22	132	29	925	188	26	728	249	49	1904	224	34	1180
23	114	22	576	174	24	848	239	50	2068	205	35	1276
24	102	23	841	156	22	528	232	45	1643	201	33	1037
25	94	19	573	142	17	482	220	38	1495	188	35	1482
26	80	17	477	127	18	508	207	55	2024	173	32	1093
27	71	13	327	116	14	414	192	32	1324	157	30	1136
28	60	7	259	102	14	384	174	30	1156	141	26	992
29	54	10	224	95	15	489	157	25	1018	127	24	739
30	47	5	114	90	11	332	146	24	920	114	21	760
31	41	6	234	83	17	542	133	34	1288	105	14	418
32	40	8	175	77	13	415	115	14	686	91	10	324
33	34	6	165	69	13	410	109	23	753	77	9	261
34	30	5	131	60	8	257	93	17	585	70	8	273
35	25	2	56	51	4	59	81	11	372	57	12	310
36	21	3	68	39	8	215	64	9	401	47	6	170
37	15	1	5	34	3	52	55	11	430	44	9	298
38	13	3	121	28	3	86	48	9	315	35	4	169
39	9	1	30	26	4	72	45	8	287	31	5	183
40	8	2	63	22	3	44	40	6	203	26	6	159
41	7	2	50	19	3	51	34	6	236	21	3	45
42	6	2	15	16	5	95	31	6	232	17	2	64
43	5	2	29	13	2	92	24	6	204	14	4	151
44	3	2	5	11	3	89	23	5	151	11	3	76
45	3	—	—	8	2	80	21	1	22	7	2	120
46	2	1	28	5	1	16	16	—	—	6	2	60
47	2	—	—	2	1	12	13	1	42	5	—	10
48	1	—	—	1	—	—	12	3	81	5	1	28
49	1	—	—	1	—	—	7	1	30	5	1	25
50	1	—	—	1	—	—	6	—	—	5	—	31
51	—	—	—	1	—	—	6	2	46	5	—	28
52	—	—	—	1	—	—	6	1	50	3	2	—
53	—	—	—	1	—	—	6	1	64	3	—	—
54	—	—	—	1	—	—	5	1	43	2	—	—
55	—	—	—	1	—	—	2	—	—	2	—	—
56	—	—	—	1	—	—	—	—	—	2	—	—
57	—	—	—	1	—	—	—	—	—	2	—	—
58	—	—	—	1	—	—	—	—	—	2	1	—
59	—	—	—	1	—	—	—	—	—	2	1	—
60	—	—	—	1	—	—	—	—	—	2	—	—

The investigation of this question has its obvious bearing on the problem of periodicity. Periodicity is the term used by de Vries and other biologists to express the idea that the form or size of the organs produced laterally along an axis is to some extent correlated with their position in such a manner that as one passes from the proximal to the distal region of the axis there is at first an increase to a maximum and then a decrease of the value of the character of the laterally produced organ.

TABLE XI

FREQUENCY DISTRIPUTION OF NUMBER OF SEEDS PER LOCULE IN 4 SERIES

Seeds per locule	J. B 1906	J. B 1907	M. H. 1906	M. H. 1907
?	—	14	—	10
0	307	212	104	129
1	117	96	51	80
2	139	138	91	86
3	172	162	145	130
4	153	173	153	157
5	153	161	189	200
6	164	206	224	207
7	143	225	245	249
8	143	215	278	224
9	173	218	287	253
10	143	214	293	264
11	161	213	280	280
12	124	243	329	315
13	133	219	291	302
14	151	214	300	278
15	128	218	311	255
16	134	159	348	278
17	110	183	292	242
18	105	175	286	219
19	93	111	291	197
20	82	96	218	194
21	77	85	199	106
22	66	77	198	130
23	40	42	169	109
24	40	27	136	82
25	35	34	84	60
26	28	13	79	54
27	15	16	59	36
28	10	9	32	37
29	8	5	27	14
30	6	1	28	12
31	4	—	12	8
32	—	2	11	5
33	1	—	2	4
34	2	—	3	1
35	—	—	3	—
36	—	—	1	2
37	—	—	—	1
38	—	—	2	1

The literature bearing on this problem is now fairly extensive, but little has been written concerning the possible relationship between the fertility characters of the fruit and its position on the inflorescence axis.

It should be evident that the differences in the proportion of fruits developing at different positions on the inflorescence present a series of problems of morphogenetic and physiological significance. Unfortunately the systematic collection of data for the solution of such problems has hardly been begun.

TABLE XII

FREQUENCY DISTRIBUTION OF NUMBER OF SEEDS PER FRUIT IN 4 SERIES

Seeds per capsule	II	VI	I	IV	Seeds	II	VI	I	IV	Seeds	II	VI	I	IV
?	—	13	—	8	36	22	24	31	32	73	3	4	6	8
0	47	44	1	17	37	18	29	28	30	74	3	1	8	8
1	8	3	—	3	38	18	34	38	34	75	5	—	9	5
2	16	1	—	1	39	20	34	41	40	76	1	2	5	6
3	15	5	2	1	40	16	18	40	35	77	1	2	4	2
4	16	9	2	3	41	19	24	35	41	78	2	3	12	3
5	16	11	2	11	42	18	19	34	26	79	1	1	9	6
6	13	9	7	8	43	9	23	39	31	80	3	—	8	5
7	16	12	8	7	44	16	21	37	33	81	2	2	8	1
8	16	16	13	15	45	13	29	36	33	82	—	—	2	1
9	20	19	15	11	46	17	19	44	38	83	1	—	4	3
10	15	20	16	15	47	11	31	36	39	84	1	—	1	3
11	15	16	10	18	48	16	30	31	27	85	3	1	3	4
12	20	24	14	15	49	16	26	38	33	86	1	—	2	2
13	19	22	25	21	50	14	23	38	23	87	—	—	3	—
14	20	13	16	12	51	17	22	36	24	88	—	—	—	2
15	21	28	20	15	52	12	15	36	22	89	—	—	—	—
16	28	12	31	22	53	8	15	29	23	90	—	—	1	—
17	28	21	17	25	54	13	12	31	26	91	—	—	1	—
18	14	30	23	17	55	17	10	34	22	92	—	1	1	1
19	27	29	25	31	56	12	14	36	21	93	—	—	3	—
20	26	32	31	30	57	8	13	42	20	94	—	—	1	1
21	19	16	34	33	58	10	12	30	24	95	—	—	—	—
22	15	29	50	35	59	6	7	34	12	96	—	—	1	—
23	13	24	29	34	60	13	5	19	15	97	1	—	—	1
24	16	26	31	26	61	13	10	28	21	98	—	—	—	—
25	24	22	24	31	62	6	13	25	17	99	—	—	2	—
26	18	34	33	26	63	7	10	30	22	100	—	—	—	—
27	13	32	45	37	64	3	8	24	14	101	—	—	—	—
28	31	31	29	34	65	5	8	16	15	102	—	—	1	—
29	17	29	43	38	66	5	9	21	8	103	—	—	—	—
30	17	23	38	28	67	5	5	21	17	104	—	—	—	—
31	15	33	45	35	68	6	5	12	12	105	—	—	—	—
32	11	19	30	28	69	2	5	11	11	106	—	—	—	—
33	14	22	40	40	70	6	2	13	11	107	—	—	—	1
34	12	28	37	34	71	4	2	15	9	108	—	—	—	—
35	14	31	37	43	72	6	1	10	5	109	—	—	—	—

Looking at the matter in a wholly superficial way, one is inclined to suggest, as a basis for the planning of further investigation, that the maturation of the more proximal ovaries is not favored by the conditions of the inflorescence which are most favorable for the development of the terminal portions where the floral parts are being matured for anthesis. The failure of the more distally placed ovaries to develop to maturity in such large numbers as those in the more central region of the inflorescence is possibly attributable to the demands for fruit- and seed-forming substances made by more proximal ovaries already in an advanced stage of development.

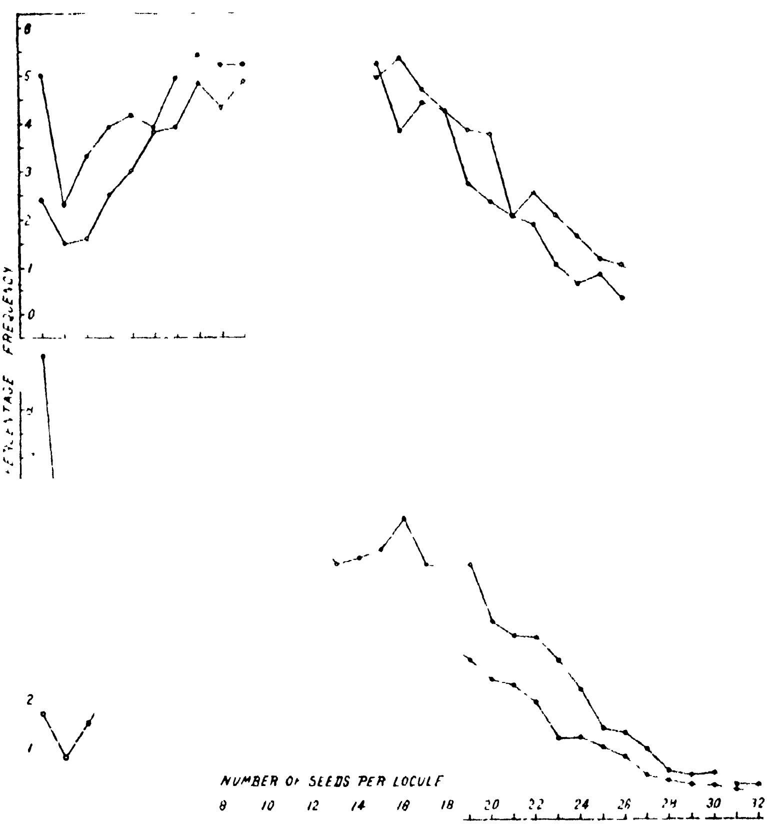

Fig. 6. Percentage frequency distribution of number of seeds per locule. Circles = Meramec Highlands, solid dots = Jefferson Barracks. Lower figure represents results for 1906, upper figure those for 1907.

The frequency distribution of number of seeds per locule in the 4 series is shown in table XI, while the distribution of number of seeds per capsule, comprising 3 locules, appears in table XII.

The distributions of seeds per locule, reduced to percentage frequencies, are represented graphically in fig. 6. These distributions require consideration from 2 sides: first, that of the differences between the series collected in different years in the same habitat, or in different habitats in the same year; second, that of their general nature as considered in comparison with biological frequency distribution in general. While neither of these questions can be fully considered independently of the other, the discussion of the difference in the material associated with year or habitat can be made in a preliminary way in simpler terms, and hence will be first taken up.

These 4 series have in common a wide range of variation in seed number, giving broad, relatively flat-topped distributions. In all series the distribution is bimodal. There is a conspicuous primary or secondary mode on 0 seeds per locule and another in the general region of 8 to 14 seeds per locule.

The agreement between the series from the habitats is in general very good in 1907, but in 1906 the 2 series differ conspicuously. That taken at Jefferson Barracks has a conspicuous mode on no

TABLE XIII

STATISTICAL CONSTANTS FOR NUMBER OF SEEDS PER LOCULE

Series	N	Mean	Standard deviation	Coefficient of variation
Meramec Highlands 1906 (I)	6051	13.7708±.0588	6.7898±.0416	49.3058±.3684
Meramec Highlands 1907 (IV)	5201	12.7963±.0623	6.6698±.0440	52.1229±.4280
Jefferson Barracks 1906 (II)	3360	10.3009±.0842	7.2394±.0595	70.2793±.8154
Jefferson Barracks 1907 (VI)	4162	10.9077±.0670	6.4086±.0473	58.7530±.5645
Differences between two years (1906—1907)				
Meramec Highlands	—	+0.9745±.0857	+0.1200±.0607	— 2.8171±.5647
Jefferson Barracks	—	−0.6068±.1076	+0.8308±.0760	+11.5263±.9917
Differences between two habitats (M.H.—J.B.)				
1906	—	+3.4699±.1027	−0.4496±.0726	−20.9735±.8948
1907	—	+1.8886±.0915	+0.2612±.0646	— 6.6301±.7084

seeds matured, and relatively high frequencies on the lower numbers of seeds per locule, whereas that taken at Meramec Highlands shows a relatively low mode on 0 seeds matured with a shift of the mode to a much higher seed number than in the Jefferson Barracks series.

To carry these comparisons somewhat further, and to prepare for more detailed consideration of the nature of these frequency distributions, we may consider the simpler statistical constants in table XIII for number of seeds per locule and in table XIV for

TABLE XIV

STATISTICAL CONSTANTS FOR NUMBER OF SEEDS PER FRUIT

Series	N	Mean	Standard deviation	Coefficient of variation
Meramec Highlands 1906 (I) . .	2017	41.3123 ± .2748	18.3094 ± .1914	44.3195 ± .5548
Meramec Highlands 1907 (IV) .	1729	38.3829 ± .2947	18.1931 ± .2085	47.3991 ± .6539
Jefferson Barracks 1906 (II)	1120	30.9027 ± .4063	20.1417 ± .2872	65.1777 ± 1.2631
Jefferson Barracks 1907 (VI) .	1379	32.8426 ± .3165	17.4688 ± .2240	53.1893 ± .8545
Differences between two years (1906–1907)				
Meramec Highlands .	—	+ 2.9294 ± .4029	+0.1163 ± .2851	− 3.0796 ± .8575
Jefferson Barracks	—	− 1.9399 ± .5150	+2.6729 ± .3642	+11.9884 ± 1.5250
Differences between two habitats (M. H.—J. B.)				
1906	—	+10.4096 ± .4905	−1.8323 ± .3468	−20.8582 ± 1.3796
1907	—	+ 5.5403 ± .4325	+0.7213 ± .3060	− 5.7902 ± 1.0760

number of seeds per fruit. The differences between the constants for the 2 years in the same habitat and between the constants for the 2 habitats in the same year also appear in these tables.

The means and standard deviations will be used in calculating the coefficients of correlation set forth in the following paragraphs.

The conspicuous feature of the tables is the large size of the coefficients of variation. It is unnecessary in this place to bring together the many coefficients of variation for number of seeds per locule or per fruit which have been published in the literature, or to do more than to say that they are generally large.

Turning to the comparisons between the 2 years in the same habitat, we note that while the difference in means is perhaps statistically significant[1] in the 2 cases it is relatively small, being about 5 per cent in the 2 instances. It is also to be noted that in one habitat it is the 1906 series, whereas in the other it is the 1907 series, which has the higher seed production.

The differences between the 2 habitats in the same year show that for both years seed production is materially and significantly higher in the Meramec Highlands than in the Jefferson Barracks plants.

2. THE RELATIONSHIP BETWEEN THE NUMBER OF FLOWERS AND THE NUMBER OF CAPSULES MATURED

The relationship between number of flowers per inflorescence and the number of fruits per inflorescence may be computed for

TABLE XV

CORRELATION BETWEEN NUMBER OF FLOWERS AND FRUITS PER INFLORESCENCE

Series	N	Correlation between number of flowers and fruits	$\frac{r}{E_r}$	Correlation, flowers per inflorescence, and deviation of fruits from their probable value	$\frac{r}{E_r}$
Meramec Highlands 1906 (I)	300	.6751±.0212	31.84	.0278±.0389	0.71
Meramec Highlands 1907 (IV)	300	.6565±.0222	29.57	−.0986±.0386	2.55
Meramec Highlands 1907 (V)	305	.6047±.0245	24.68	.0451±.0385	1.17
Meramec Highlands 1907 (IV)+(V)	605	.6261±.0167	37.49	.0343±.0274	1.25
Jefferson Barracks 1906 (II)	250	.6125±.0267	22.94	.0576±.0425	1.36
Jefferson Barracks 1906 (III)	1000	.6416±.0125	51.33	.0693±.0212	3.27
Jefferson Barracks 1906 (II)+(III)	1250	.6374±.0113	56.41	.0771±.0190	4.06
Jefferson Barracks 1907 (VI)	250	.5344±.0304	17.58	−.1035±.0422	2.45
Jefferson Barracks 1907 (VII)	1020	.6897±.0111	62.14	.0652±.0210	3.10
Jefferson Barracks 1907 (VI)+(VII)	1270	.6638±.0106	62.62	.0407±.0189	2.15

the 4 series in which the seeds were counted from the entries in table I. For the 3 other series in which only the number of flowers and fruits were determined the reader must refer to table II.

The relationship between the number of flowers formed and the number of capsules matured per inflorescence is expressed in

[1] The ordinary formulae have been used in calculating the probable errors, although the correlation between the locules of the same fruit complicates somewhat their interpretation.

terms of correlations in the first correlation column of table XV. These coefficients are remarkably uniform from series to series. They range from 0.534 ± 0.030 to 0.690 ± 0.011. These *extremes* differ by only 0.156 ± 0.032. In general the series cannot be considered to differ significantly in correlation.

The relationship between the number of capsules matured and the number of flowers formed is expressed in terms of linear regression equations in table XVI.

TABLE XVI

STRAIGHT LINE EQUATIONS SHOWING THE RELATIONSHIP BETWEEN NUMBER OF FRUITS AND FLOWERS PER INFLORESCENCE

	Regression equation
Meramec Highlands 1906 (I)	$c = -\ 2113 + .2316\,f$
Meramec Highlands 1907 (IV)	$c = -\ .1139 + .2138\,f$
Meramec Highlands 1907 (V)	$c = -\ 3830 + .2280\,f$
Meramec Highlands 1907 (IV) + (V)	$c = -\ .2652 + .2216\,f$
Jefferson Barracks 1906 (II)	$c = -\ .3602 + .2062\,f$
Jefferson Barracks 1906 (III)	$c = -\ 5348 + .2382\,f$
Jefferson Barracks 1906 (II) + (III)	$c = -\ 5346 + .2335\,f$
Jefferson Barracks 1907 (VI)	$c = +\ 7869 + .1755\,f$
Jefferson Barracks 1907 (VII)	$c = -\ .4719 + 2191\,f$
Jefferson Barracks 1907 (VI) + (VII)	$c = -\ 3002 + .2376\,f$

The slopes of these lines range from + .1755 in the series of 250 inflorescences taken at Jefferson Barracks in 1907 to + .2491 in the large series taken at the same locality in the same year.

The fact that the widest disagreement is found in 2 series from the same habitat and year emphasizes the closeness of agreement between the results of the several series.

The equations for 2 of the series are represented graphically in fig. 7 for 1906, in which the empirical and theoretical means for 2 different habitats but for the same year, are laid side by side.

Two features of these diagrams will at once attract the eye: first, the excellent fit of the straight lines to the data; second, the remarkable closeness of agreement of the series from the 2 habitats.

While the correlation coefficients and the regression equations showing the relationship between the number of flowers and capsules per inflorescence have descriptive value, the physiological interrelationship between f and c may be best shown by a coefficient measuring the relationship between the number of flowers

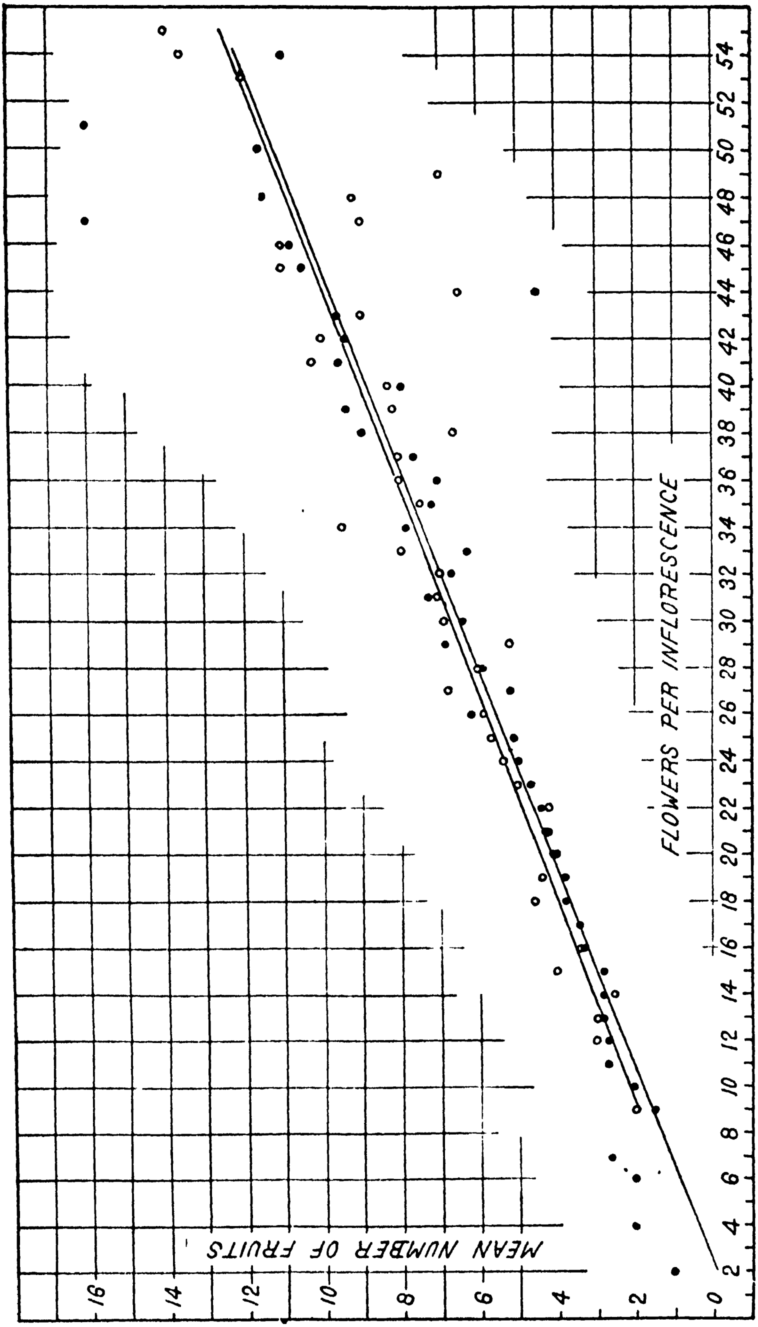

Fig. 7. Regression of number of fruits on number of flowers per inflorescence. Upper line = Meramec Highlands; lower line = Jefferson Barracks. Empirical means for Meramec Highlands represented by circles, those for Jefferson Barracks by solid dots.

and the deviation of the number of fruits from the number which would be expected if the number of capsules were proportional to the number of flowers formed throughout the entire range of variation of number of flowers per inflorescence.

The requisite formula has been given (Harris, '09a) and its range of applicability illustrated elsewhere (Harris, '18).

The results are given in the second correlation column of table xv. The values are low throughout. Eight are positive, while 2 are negative in sign. In general the coefficients are insignificant in comparison with their probable errors.

Taking these results as a whole, they indicate a slight relationship between the number of flowers per inflorescence and the capacity of the inflorescences for maturing their ovaries into fruits. Larger inflorescences mature on the average a slightly, but only slightly, larger proportion of their ovaries into fruits.

Turning to the literature for comparable cases, we note that in *Staphylea* (Harris, '09 a) and in *Crinum* (Harris, '12 a) inflorescences which produce larger numbers of flowers mature relatively smaller numbers of fruits. This is also the result announced by Reed for the lemon (Reed, '19). In *Celastrus* (Harris, '09) there is apparently no relationship between the number of flowers formed and the capacity of the inflorescence for maturing its ovaries into fruits.

3. THE RELATIONSHIP BETWEEN THE NUMBER OF FLOWERS PER INFLORESCENCE AND THE POSITION OF THE FRUITS

The foregoing analysis has shown that there is little relationship between the size of the inflorescence and the capacity for maturing its ovules into seeds.

We now have to consider another problem regarding fruit formation. This is: Has the size of the inflorescence as measured by the number of flowers which it produces an influence upon the position of the fruits which develop?

The problem of the relationship between the number of flowers and the position of the fruits which develop to maturity seems to be one of very real physiological interest. If we ignore for the moment the possible influence of the morphogenetic factor discussed above (p. 434) and look at the purely nutritional one, it

seems reasonable to assume that development of fruit makes a certain demand upon the organism for plastic materials. If this demand is higher than the available supply in any case, it seems quite possible that the more proximal ovaries, which are the first to have their seeds fertilized, would develop into fruits in larger proportions, since they are in a position to make the first demand upon the plastic materials.

If, on the other hand, the organism is so exactly coordinated that the quantities of plastic materials available for the formation of fruits and seeds is proportional to the number of flowers formed,[1] one might expect that the position of the fruits would be little influenced by the number of flowers per inflorescence.

To solve this problem we may proceed in the following manner. We may determine the relation between the number of flowers per inflorescence and the position of the fruits which develop to maturity. In doing this we weight the number of flowers per inflorescence with the number of fruits produced, and consider the position of each fruit on the axis a deviation from the standard (proximal) position.[2] We must expect this relation to be large, since it is evident that on the average the fruits on large inflorescences, which produce more fruits, will be inserted higher than those which produce few fruits. It is possible, however, to determine the true physiological relationship between these 2 characters by the use of the formula measuring the relation between a variable and the deviation of a dependent variable from its probable value cited above. The position of any fruit must always represent some fraction, or component, of the maximum possible position on the inflorescence to which it belongs. This formula, therefore, seems quite applicable.

The correlation between the number of flowers per inflorescence and the position of the fruits on the inflorescence, and between the number of flowers on the inflorescence and the deviation of the position of the fruits from its probable position appear in table XVII.

[1] One may, if he chooses, look upon the number of flowers formed as very closely proportional to the quantities of plastic substances which are to be available for maturing these ovaries into fruit.

[2] The full data for the determination of these constants are rather too voluminous for publication here.

TABLE XVII

CORRELATION BETWEEN POSITION OF FRUITS ON THE INFLORESCENCE AND NUMBER OF FLOWERS PER INFLORESCENCE

Series	Weighted N	Correlation between number of flowers and position of fruits	$\frac{r}{E_r}$	Correlation, flowers per inflorescence and deviation of position of fruits from its probable position	$\frac{r}{E_r}$
Meramec Highlands 1906 (I)	2017	.4151 ± .0322	12.89	.0162 ± .0389	0.42
Meramec Highlands 1907 (IV)	1737	.4605 ± .0307	15.00	.0314 ± .0389	0.81
Meramec Highlands 1907 (V)	1849	.4791 ± .0297	16.14	.0216 ± .0386	0.56
Meramec Highlands 1907 (IV) + (V)	3586	.4726 ± .0213	22.18	.0291 ± .0274	1.06
Jefferson Barracks 1906 (II)	1120	.4843 ± .0327	14.81	− .0332 ± .0426	0.78
Jefferson Barracks 1906 (III)	5361	.4266 ± .0174	24.51	.0280 ± .0213	1.31
Jefferson Barracks 1906 (II) + (III)	6481	.4328 ± .0155	27.92	.0151 ± .0191	0.79
Jefferson Barracks 1907 (VI)	1392	.4677 ± .0333	14.04	.0536 ± .0425	1.26
Jefferson Barracks 1907 (VII)	6534	.4314 ± .0171	25.40	− .0151 ± .0211	0.72
Jefferson Barracks 1907 (VI) + (VII)	7926	.4399 ± .0153	28.75	− .0057 ± .0191	0.30

If there be no relationship between the number of flowers per inflorescence and the position of the fruits on the inflorescence, one should find a linear relationship between the average position of the fruits and the number of flowers per inflorescence. The equations to the straight lines in 4 of the series are:

Meramec Highlands, 1906, 300 inflorescences, 2017 fruits

$$p = -.554747 + .482806\,f$$

Jefferson Barracks, 1906, 1250 inflorescences, 6481 fruits

$$p = -.400325 + .472802\,f$$

Meramec Highlands, 1907, 605 inflorescences, 3586 fruits

$$p = -.857833 + .512934\,f$$

Jefferson Barracks, 1907, 1270 inflorescences, 7926 fruits

$$p = +.160829 + .447496\,f$$

The lines and empirical means for the 1906 series appear in fig. 8. The results indicate sensible linearity.

Turning to the problem of the correlation between number of flowers per inflorescence and deviation of position of fruits from its probable value, we note that the values are low throughout. They are generally smaller than their probable errors. Thus they indicate that the number of flowers per inflorescence has practically no influence on the position of the fruits which develop to maturity.

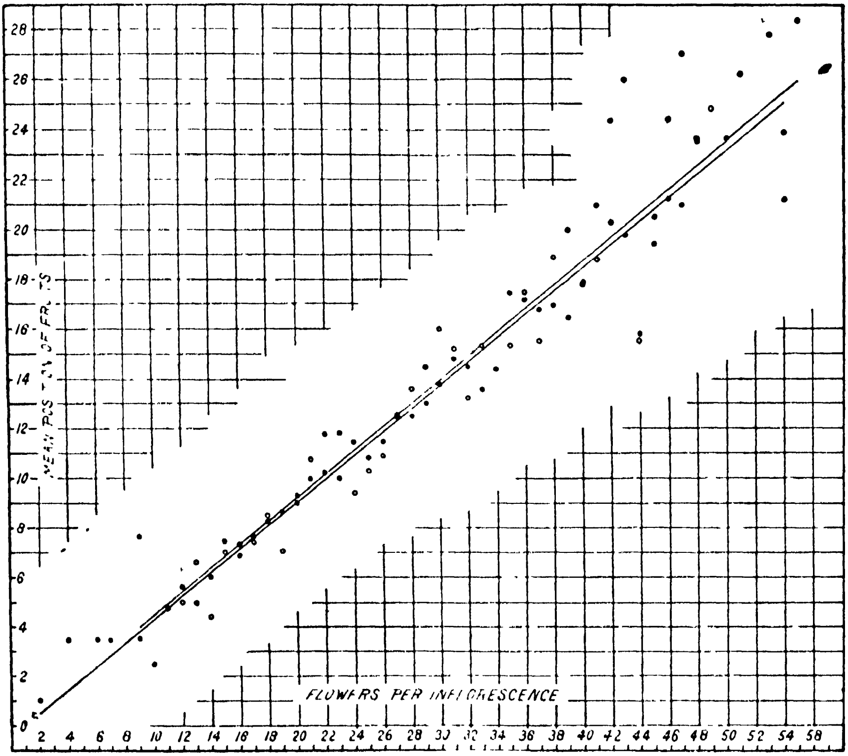

Fig. 8 Regression of position of fruits on number of flowers per inflorescence in 2 habitats for 1906. Upper line and circles = Meramec Highlands, lower line and solid dots = Jefferson Barracks.

In so far as they are pertinent to the problem, the constants in this table seem to show that the supply of fruit- and seed-forming substance is very nearly proportional to the number of flowers formed. These results are in full agreement with those of the preceding section (2) in which it was shown that there is little relationship between the number of flowers on the inflorescence and the capacity of the inflorescence for maturing these flowers into fruit.

4. THE RELATIONSHIP BETWEEN THE NUMBER OF FLOWERS AND FRUITS PER INFLORESCENCE AND THE NUMBER OF SEEDS PER LOCULE

We have, in this section, to consider the problem of the possible relationships between the size of the inflorescence as measured by

the number of flowers and fruits which it produces and the fertility of its fruits.

This seems a question of very real physiological interest On *a priori* grounds one might be inclined to suggest that the size of the inflorescence is a measure of vigor, and that, as another expression of the greater vigor, larger numbers of seeds would be expected to be associated with larger numbers of flowers per inflorescence. On the other hand, it may be urged that since the inflorescences with larger numbers of flowers also produce larger numbers of fruits, the demands for plastic materials due to greater numbers of fruits would result in a reduction rather than in an increase in the number of seeds per locule.

The product moments for the relationship between the number of flowers per inflorescence and numbers of seeds per fruit may be calculated from table I.[1]

Table XVIII shows the correlation between the number of flowers per inflorescence and the number of seeds per locule and between the number of fruits per inflorescence and the number of seeds per locule in the 4 series in which the numbers of seeds were determined.

Three of the constants measuring the relationship between the number of flowers and the number of seeds are positive, while one is negative in sign. All are small, however, ranging from -0.020 to $+0.095$. In general the coefficients are not as large as their probable errors.[2]

Correlations between the number of fruits per inflorescence and

[1] Note that in determining the relationship between number of flowers and number of seeds the means and standard deviations for number of flowers per inflorescence must be redetermined by weighting with the number of fruits or number of locules per inflorescence. The constants thus weighted may be used in the determination of correlations for number of flowers and number of seeds per locule or seeds per fruit, since all of the fruits are trilocular.

[2] The question of the number to be used in calculating the probable error of these constants has presented considerable difficulty. The number of fruits in which the seeds were counted has been very large. If this N were used in the determination of the probable error it would be very small indeed. It may be questioned, however, whether the probable error of the correlation between a weighted variable x and another variable y is any lower than that obtained when the unweighted number of the x characters is used. We have, therefore, in determining these probable errors taken N to be the actual number of inflorescences.

the number of seeds per locule may be deduced from the condensed correlation table appearing as table IV.[1]

The correlations between the number of fruits and the number of seeds per locule as given in table XVIII are negative in all 4 of the cases but are of a very low order, ranging from -0.043 to -0.127. Two of the 4 are over twice as large as their probable errors.

TABLE XVIII

CORRELATION BETWEEN FLOWERS PER INFLORESCENCE AND NUMBER OF SEEDS PER LOCULE AND BETWEEN NUMBER OF FRUITS PER INFLORESCENCE AND NUMBER OF SEEDS PER LOCULE

Series	Flowers and seeds	$\frac{r}{E_r}$	Fruits and seeds	$\frac{r}{E_r}$	Difference	$\frac{\text{Diff.}}{E_{\text{diff.}}}$
Meramec Highlands 1906	$+.0321 \pm .0389$	0.825	$-.0429 \pm .0389$	1.102	$-.0750 \pm .0387$	1.938
Meramec Highlands 1907 ..	$+.0382 \pm .0388$	0.985	$-.0569 \pm .0388$	1.466	$-.0951 \pm .0387$	2.457
Difference..	$+.0061 \pm .0548$	0.111	$-.0140 \pm .0548$	0 255	———	—
Jefferson Barracks 1906	$+.0952 \pm .0423$	2.250	$-.0867 \pm .0423$	2.050	$-.1819 \pm .0424$	4.290
Jefferson Barracks 1907	$-.0202 \pm .0426$	0.474	$-.1265 \pm .0420$	3.012	$-.1063 \pm .0600$	1.772
Difference..	$-.1154 \pm .0600$	1.923	$-.0398 \pm .0600$	0.663	———	—

These results show that unless there are statistical considerations which invalidate the coefficients of correlation as measures of interdependence in these cases, the relationship between the characteristics of the inflorescence and the number of seeds matured is very slight indeed. Apparently inflorescences which are initially large tend to have capsules with slightly larger numbers of seeds. Inflorescences which mature a large number of capsules tend to have a slightly smaller number of seeds in these capsules. The difference between the correlations for number of fruits and seeds and the number of flowers and seeds shows that in all 4

[1] The frequencies used in calculating the correlations given in this paper are slightly different from those shown here because of the fact that 10 locules in series IV and 14 locules in series VI had a questionable number of seeds. The difference in results obtained from calculations from this table and those actually used in obtaining our constants can hardly be significant, since they depend merely on differences due to 10 out of 5211 and 14 out of 4176 locules.

collections the relation between number of fruits and seeds is more strongly negative than that between number of flowers and seeds. At least 2 of these differences may be significant in comparison with their probable errors.

The correlation coefficients in these tables show that the relationship between the number of flowers per inflorescence and the number of seeds per locule and between the number of fruits per inflorescence and the number of seeds per locule is very slight indeed. How slender it is may be best shown by the use of straight-line equations. In these the variable term shows the actual increase or decrease in number of seeds per locule associated with an increase in the number of flowers per inflorescence or in the number of fruits per inflorescence. The equations are:

Meramec Highlands, 1906,

$$s = 12.9611 + .0250\,f, \quad s = 14.5414 - .0965\,c$$

Meramec Highlands, 1907,

$$s = 11.9176 + .0291\,f, \quad s = 13.7444 - .1335\,c$$

Jefferson Barracks, 1906,

$$s = 8.1589 + .0822\,f, \quad s = 11.5831 - .2173\,c$$

Jefferson Barracks, 1907,

$$s = 11.3520 - .0151\,f, \quad s = 12.6892 \quad .2585\,c$$

where s = seeds, f = flowers, and c = fruits per inflorescence.

The lines and the empirical means are represented graphically for the relationship between number of flowers per inflorescence and number of seeds per locule in fig. 9, and for that between number of fruits per inflorescence and number of seeds per locule in fig. 10.

The mean numbers of seeds per locule are distributed with considerable irregularity about the nearly horizontal lines showing the theoretical change in mean number of seeds with variation in the number of flowers per inflorescence. There is, however, nothing in these lines to indicate that any single curve of a higher order would give a better representation of the relationship.

The lines and empirical means for number of seeds per locule of fruits produced on inflorescences with varying total numbers of fruits (fig. 10) may indicate a slightly non-linear distribution of

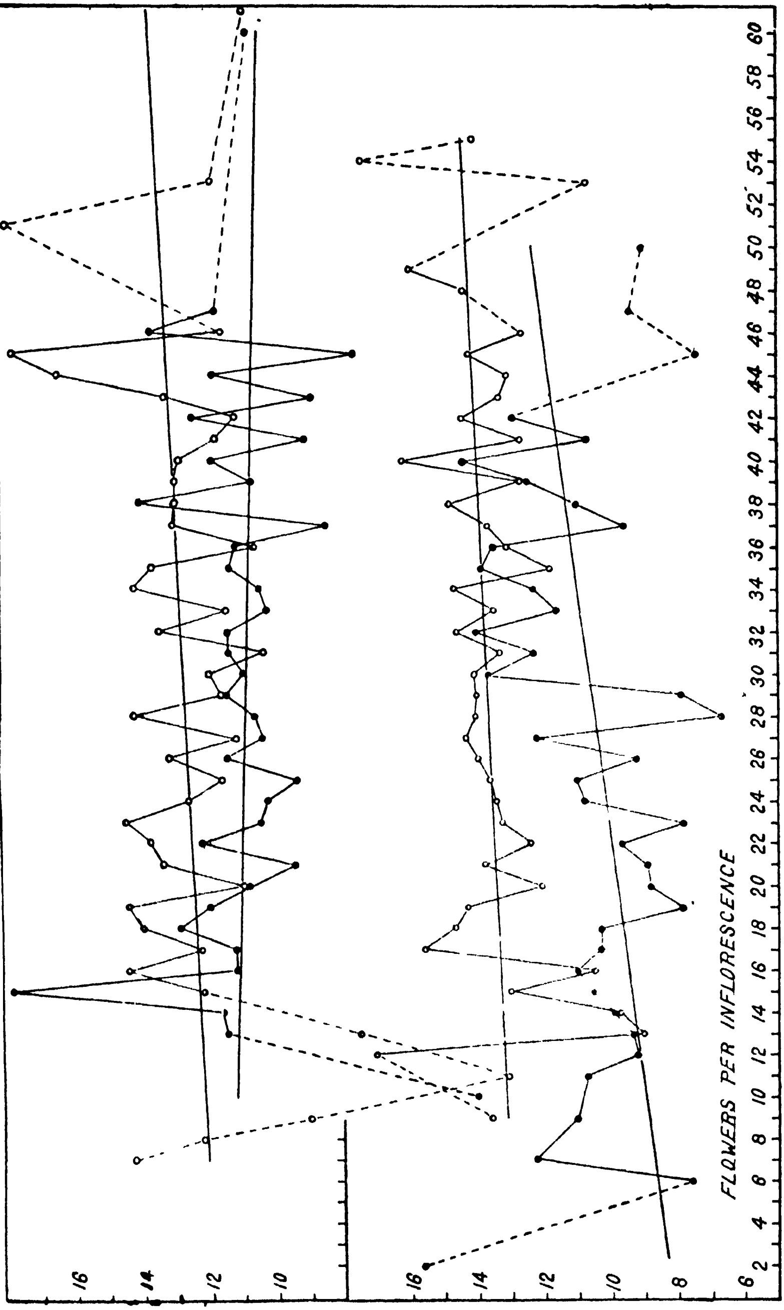

Fig. 9. Regression of number of seeds per locule on number of flowers per inflorescence. Circles represent empirical means for Meramec Highlands, solid dots those for Jefferson Barracks. Lower figure gives results for 1906, upper fiugre those for 1907.

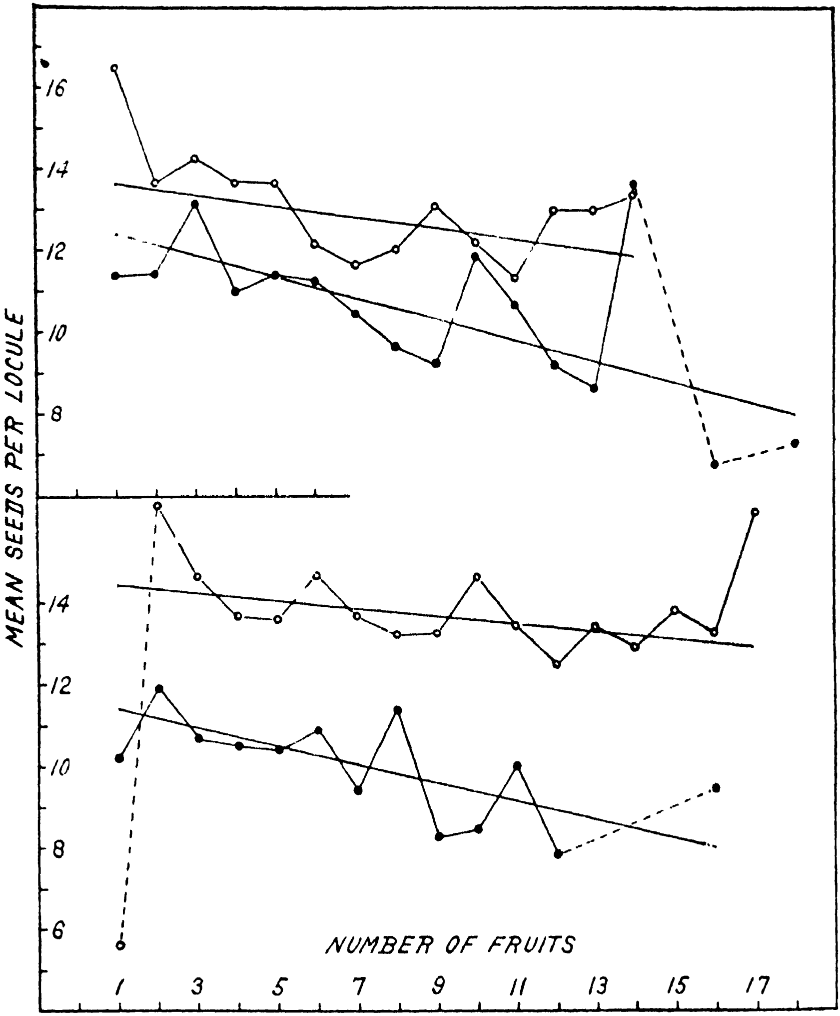

Fig. 10. Regression of number of seeds per locule on number of fruits per inflorescence. Circles represent empirical means for Meramec Highlands, solid dots those for Jefferson Barracks. Lower figure represents results for 1906, upper figure those for 1907.

the means.[1] They show, however, that there is a sensible decrease

[1] Further mathematical tests for non-linearity seem unadvisable because of the difficulties arising from the small frequencies in some of the classes, and because of the fact that the relationship between fruit and seed number is complicated by the relationship between flower and fruit number and flower and seed number, as shown in the following paragraphs.

in the number of seeds per fruit as the number of fruits per inflorescence increases.

We may therefore conclude that the correlation coefficient furnishes as adequate a measure of the relationship between the number of flowers per inflorescence and seeds per fruit, and fruits per inflorescence and seeds per fruit, as we are able to command. This measure shows that the relationship is, practically speaking, zero for the number of flowers and the number of seeds, but has a significant negative value for number of fruits matured per inflorescence and number of seeds ripened per locule.

It will be quite evident on mature consideration that the very low correlation between number of flowers per inflorescence and number of seeds may be the resultant of physiological relationships between number of capsules and number of seeds on the one hand, and the number of capsules and number of flowers, on the other. Inflorescences producing larger numbers of flowers also produce larger numbers of fruits. As a resultant of the positive correlation between number of flowers and capsules per inflorescence, r_{fc}, and of the negative correlation between number of fruits and number of seeds per locule, r_{cs}, one might expect the correlation between number of flowers and number of seeds to be sensibly lowered.[1]

It is necessary, therefore, to determine the partial correlation between number of flowers per inflorescence and number of seeds for constant number of capsules per inflorescence. This is given by

$$_{c}r_{fs} = \frac{r_{fs} - r_{fc}r_{cs}}{\sqrt{1 - r_{fc}^2}\sqrt{1 - r_{cs}^2}}$$

The values of $_{c}r_{fs}$ are set forth in table XIX. All 4 values are now positive. Furthermore they are (as shown by the difference column, $_{c}r_{fs} - r_{fs}$) larger than the uncorrected correlations.

Thus they indicate that if correction be made for the influence of the number of fruits whch mature, the inflorescences which are

[1] In inflorescences with larger numbers of fruits the plastic materials must be more extensively divided than in those with a small number of fruits. Number of fruits per inflorescence might, therefore, seem a more logical proximate cause of variation in the number of seeds matured than would number of flowers per inflorescence.

TABLE XIX

PARTIAL CORRELATION BETWEEN FLOWERS PER INFLORESCENCE AND SEEDS PER LOCULE FOR CONSTANT NUMBER OF FRUITS AND BETWEEN FRUITS AND SEEDS PER LOCULE FOR CONSTANT NUMBER OF FLOWERS PER INFLORESCENCE AND COMPARISON OF THE PARTIAL CORRELATIONS WITH THE GROSS CORRELATIONS

Series	Partial correlation, flowers and seeds ${}_c r_{fs}$	${}_c r_{fs} - r_{fs}$	Partial correlation, fruits and seeds ${}_f r_{cs}$	${}_f r_{cs} - r_{cs}$
Meramec Highlands 1906 (I)	+.0829 ± .0387	+.0508	−.0875 ± .0836	−.0446
Meramec Highlands 1907 (IV)	+.1003 ± .0385	+.0621	−.1088 ± .0385	−.0519
Jefferson Barracks 1906 (II)	+.1885 ± .0411	+.0932	−.1844 ± .0412	−.0977
Jefferson Barracks 1907 (VI)	+.0565 ± .0425	+.0767	−.1370 ± .0419	−.0105

larger, as measured by the number of flowers which they produce, ripen slightly larger numbers of seeds per locule.

The reader will have noted that if the physiological relationship between size of inflorescence and number of seeds per locule be of a positive kind, such that (other factors being eliminated) larger inflorescences tend to mature larger numbers of seeds in their locules, this will tend to screen the true physiological relationship between the number of fruits matured per inflorescence and the number of seeds ripened per locule.

We therefore require the partial correlation between the number of capsules and number of seeds for constant number of flowers per inflorescence. The required formula is:

$$ {}_f r_{cs} = \frac{r_{cs} - r_{fc} r_{fs}}{\sqrt{1 - r_{fc}^2}\sqrt{1 - r_{fs}^2}} $$

The coefficients are given in table XIX. These are negative throughout, and all have a higher negative value than that of the uncorrected correlation.

Turning to the literature for comparable observations, we note that while data for size of inflorescence and number of seeds per fruit cannot be obtained in *Cercis*, we do have a series of ovaries (Harris, '12) in which the number of ovules was counted under the microscope. The correlations between the number of flowers per inflorescence and the number of ovules per ovary have been shown to be: For tree 1, $r = -.007 \pm .023$; for tree 2, $r = +.030 \pm .021$; for tree 3, $r = +.134 \pm .024$. These constants are so low that their significance is questionable.

In *Celastrus* (Harris, '09) the correlation between both number of flowers and number of fruits per inflorescence, on the one hand, and number of seeds per fruit, on the other, are very low. The actual constants are:

For number of flowers and number of seeds, $r = + .033 \pm .013$.

For number of fruits and number of seeds, $r = - .012 \pm .013$.

The inflorescence and fruit of *Staphylea* has been rather exhaustively studied. It has been shown (Harris, '12b) that the average values of the correlation coefficients for a series of 20 shrubs studied at the Missouri Botanical Garden in 1906 are:

For fruits per inflorescence and ovules per locule,

$$r = .0192 \pm .0185.$$

For fruits per inflorescence and seeds per locule,

$$r = - .0399 \pm .0080.$$

For general samples of fruits, comprising the collections from all the shrubs, the correlations have been shown to be:

Year of collection	Number of locules	Fruits and ovules, r_{fo}	Fruits and seeds, r_{fs}
1906	6177	$+.0391 \pm .0086$	$-.0474 \pm .0086$
1908	12099	$+.0633 \pm .0061$	$-.0494 \pm .0061$
1909	6246	$-.0539 \pm .0085$	$+.0626 \pm .0085$

Two of the coefficients are negative. The correlation between the number of fruits per inflorescence and length of fruit in *Staphylea* has been found (Harris, '12) to be of the order $r = - .1828 \pm .0144$.

For *Crinum longifolium* (Harris, '12 a) the correlation between the number of fruits per inflorescence and number of seeds per fruit is $r = - .072 \pm .024$.

5. THE RELATIONSHIP BETWEEN THE ACTUAL AND THE RELATIVE POSITION OF THE FRUIT ON THE INFLORESCENCE AND THE NUMBER OF SEEDS PRODUCED

The proportion of the ovaries which develop into fruits at different positions on the inflorescence axis has already been discussed (p. 425).

In considering the influence of position on the inflorescence upon the development of the fruit, the only measure of position which requires consideration is that furnished by the position of the

flower. When we turn to the problem of the influence of position upon the development of the seed, it is clear that either the position of the flower on the axis or the position of the matured fruits in the series of fruits may be taken as a measure of position. Position in the latter case may be either the actual position which the matured ovary occupies in the series of flowers on the inflorescence or it may be the position which a fruit occupies in the series of fruits matured. For example, if the third flower from the proximal end of the inflorescence develops into a fruit it will be recorded as occupying the third position in the series of flowers. But if the first 2 flowers fail to develop it will occupy the first position in the series of fruits.

The first of these may be designated as the actual position of the fruit, the second as the relative position of the fruit.[1]

The total number of flowers, the total number of fruits, and the total number of seeds produced at each (actual) position on the inflorescence are shown for the 4 series of materials in which the number of seeds was determined in table x. From this table the correlations between actual position and number of seeds per locule, set forth in table xx, have been deduced.

The correlation between the relative position of the fruit and number of seeds per locule or per fruit may be deduced from the condensed correlation table xxi, in which the position of the fruit, the number of locules, and total number of seeds produced by those locules are shown for the 4 series of material in which number of seeds was determined.[2]

The relationship between the actual position of the fruit and the number of seeds matured per locule and that between the relative position of the fruit and the number of seeds matured per locule are laid side by side in table xx. These coefficients are, without exception, negative in sign. Thus the number of seeds

[1] Since in correlations between position on the inflorescence and number of seeds per locule or per fruit the position must be weighted with the number of fruits counted, the weighted constants are necessary. These may be deduced from the tables of data, but, since they are needed only for the correlations, are not tabled here.

[2] The correlation between the relative position and total seeds per fruit may be determined from this table by substituting the number of fruits for the number of locules and the means and the standard deviations of number of seeds per fruit for number of seeds per locule.

TABLE XX

CORRELATION BETWEEN THE ACTUAL POSITION OF THE FRUIT AND NUMBER OF SEEDS PER LOCULE AND BETWEEN THE RELATIVE POSITION OF THE FRUIT AND NUMBER OF SEEDS PER LOCULE

Series	Actual position and seeds	$\frac{r}{E_r}$	Relative position and seeds	$\frac{r}{E_r}$	Difference	$\frac{\text{Diff.}}{E_{\text{diff.}}}$
Meramec Highlands 1906 ..	—.0778±.0387	2.010	—.0541±.0388	1.394	+.0237±.0548	0.432
Meramec Highlands 1907 ..	—.1129±.0384	2.940	—.0500±.0388	1.288	+.0629±.0539	1.167
Difference..	—.0351±.0539	0.651	+.0041±.0548	0.075	———	—
Jefferson Barracks 1906	—.1147±.0420	2.730	—.1232±.0420	2.933	—.0085±.0592	0.143
Jefferson Barracks 1907	—.1229±.0420	2.926	—.1040±.0421	2.470	+.0189±.0592	0.319
Difference .	—.0082±.0592	0.139	+.0192±.0592	0.324	———	—

TABLE XXI

NUMBER OF LOCULES AND TOTAL SEEDS AT VARIOUS RELATIVE POSITIONS ON THE INFLORESCENCE IN 4 SERIES IN WHICH NUMBER OF SEEDS WAS DETERMINED

Relative position	J. B. 1906		J. B. 1907		M. H. 1906		M. H. 1907	
	Locules	Total seeds	Locules	Total seeds	Locules	Total seeds	Locules	Total seeds
1	744	8267	747	8313	897	12278	891	11134
2	702	7671	731	8673	894	12641	869	11973
3	600	6153	687	7659	864	12553	833	11055
4	435	4568	582	6462	795	11051	711	9374
5	297	2757	453	5068	687	9392	558	6753
6	204	1948	326	3243	552	7527	448	5391
7	141	1395	222	2182	411	5577	318	3711
8	96	816	138	1243	333	4400	219	2836
9	60	551	96	953	231	2982	144	1767
10	42	239	66	612	153	1934	84	980
11	18	146	45	348	108	1437	57	722
12	9	71	27	251	63	789	45	551
13	3	11	15	103	30	393	18	248
14	3	1	9	111	15	142	6	59
15	3	16	6	16	9	150	—	—
16	3	1	6	109	6	68	—	—
17	—	—	3	37	3	13	—	—
18	—	—	3	15	—	—	—	—

matured in the more distal position is smaller than that in the more proximal position. The differences between the correlations for the same habitat for the 2 years cannot be considered significant in comparison with their probable errors. The corre-

lations are, however, of a very low order. Those for actual position and the number of seeds range from — 0.078 to — 0.123. Those for relative position and number of seeds range from — 0.050 to — 0.123. A comparison of the correlations between

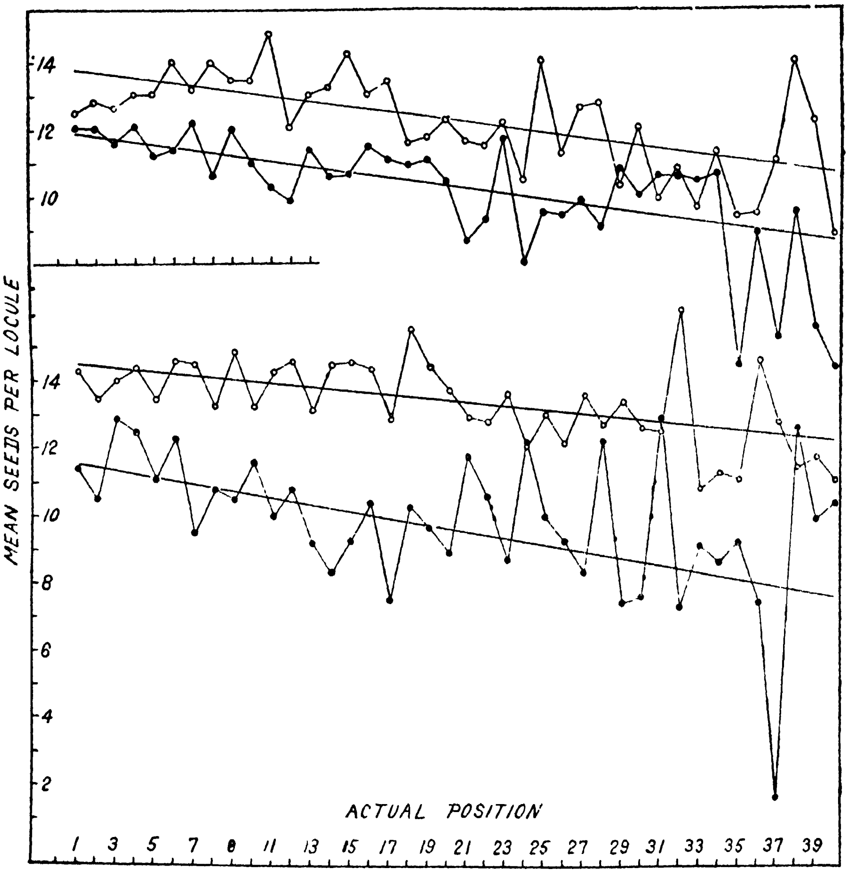

Fig. 11. Regression of number of seeds per locule on actual position of the fruit. Circles = Meramec Highlands, solid dots = Jefferson Barracks. The lower figure gives the results for 1906, the upper figure those for 1907.

the relative position and number of seeds, and actual position and number of seeds shows that in one case the former and in 3 cases the latter is the larger. No one of these differences is significant in comparison with the probable error of the determination. Thus it is impossible to assert on the basis of the materials now

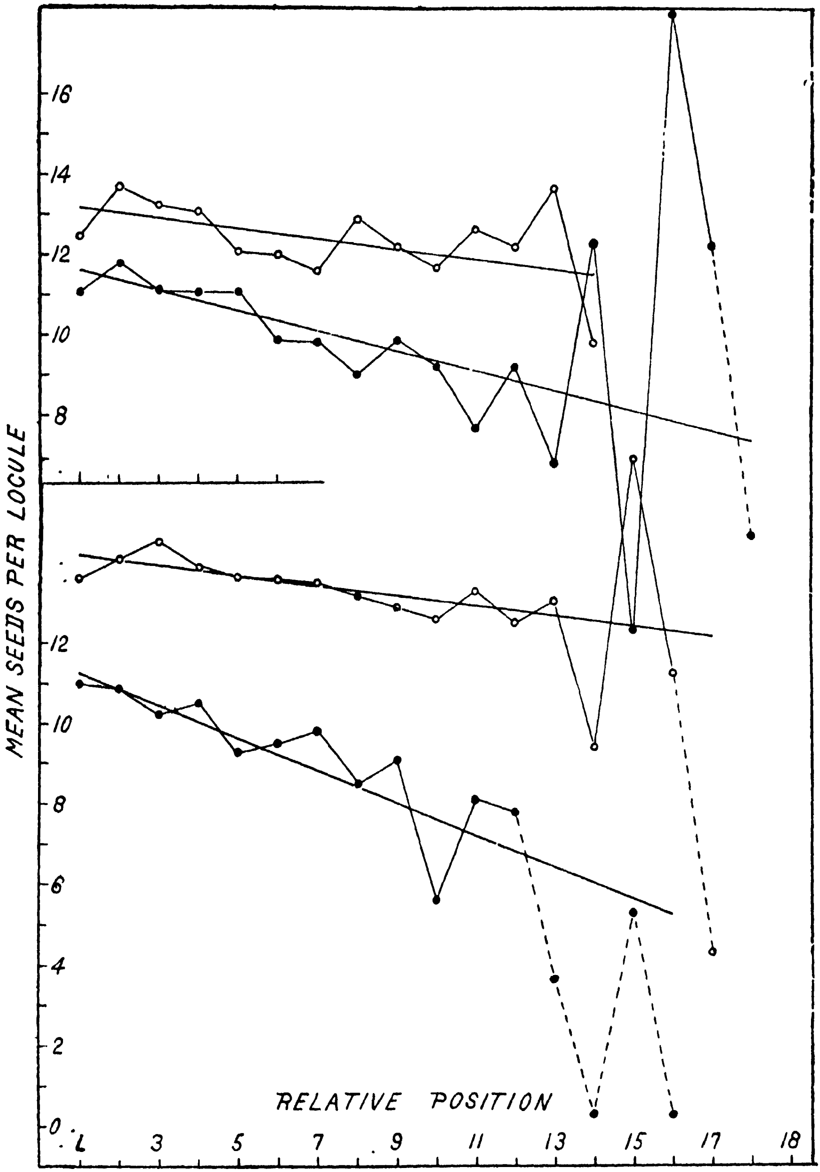

Fig. 12. Regression of number of seeds per locule on relative position of the fruit. Circles = empirical means for Meramec Highlands, solid dots = empirical means for Jefferson Barracks. Lower figure gives results for 1906, upper figure for 1907.

available that one of these relationships is more intimate than the other.

• The low correlations between the actual position and the relative position of the fruit and the number of seeds which it produces may be due either to an absence of relationship between these two characters or it may be due to a periodicity in the inflorescence, such that the number of seeds at first increases and then decreases as one passes from the proximal toward the distal end of the inflorescence.

To test this matter we determine the mean number of seeds in each position, both actual and relative, on the inflorescence, and ascertain whether the change in mean number of seeds occurs at a uniform rate from the lower to the higher regions of the inflorescence. To be strictly valid the correlation coefficients should represent cases of linear regression. The linear equations showing the change in the number of seeds per locule with position on the inflorescence are as follows:

	Actual position	Relative position
Meramec Highlands, 1906	$s = 14.5551 - .0519\,a$	$s = 14.3458 - .1280\,r$
Meramec Highlands, 1907	$s = 13.9185 - .0787\,a$	$s = 13.3141 - .1279\,r$
Jefferson Barracks, 1906	$s = 11.6245 - .0980\,a$	$s = 11.6010 - .3769\,r$
Jefferson Barracks, 1907	$s = 12.0439 - .0850\,a$	$s = 11.8913 - .2491\,r$

Here a = actual position, r = relative position, and s = number of seeds per locule.

The lines for actual position are represented in fig. 11, while those for relative position appear in fig. 12. For both relationships and in all series of material these indicate a uniform decrease in number of seeds per inflorescence when the capsules are considered in series ranging from the proximal to the distal regions of the inflorescence.

For comparison we have a number of determinations on the inflorescence of *Staphylea*, in which the relationship between position and number of ovules (Harris, '11 a) and between position and number of seeds (Harris, '12 b) have been shown to be very small numerically but generally negative in sign. The relationship between position on the inflorescence and length of pod in *Staphylea* has also been shown (Harris, '12) to be slightly negative.

6. THE RELATIONSHIP BETWEEN THE NUMBER OF SEEDS IN THE LOCULES OF THE SAME FRUIT

The correlations between the number of flowers and fruits per inflorescence and the actual and relative position of the fruit on the inflorescence, on the one hand, and the number of seeds per locule, on the other, have been shown to be of a very low order indeed. We cannot, therefore, regard any of these earlier established characters, or the factors which determine them, as having a large influence in determining the number of seeds per locule.

Having failed to locate factors of material importance in the characters of the inflorescence, we may inquire whether there are unmeasurable factors which influence all of the locules of the same fruit in a similar manner.

This may be done by determining the inter-locular relationship for number of seeds per locule in the different series. In doing this, symmetrical tables are formed. The number of seeds in each locule is considered a first and then a second member of the pair in combination with the other locules of the fruit. The values of the correlation coefficients were checked by the use of the intra-class correlation formulae (Harris, '13).

The tables of data are too voluminous for publication.

The correlation coefficients and the regression equations are set forth in table XXII and show a high degree of similarity between numbers of seeds in the locules of the same fruit. The correlation lies between 0.70 and 0.80. Since the tables are symmetrical, the correlation and the regression coefficients are identical. The straight lines and the empirical means for the materials for the 2 pairs of years are shown in fig. 13. Apparently the straight line represents the relationship between the observed and the theoretical average as well as would any curve of higher order. The closely contiguous position of the lines for the years shows the generality of the laws underlying the interdependence between seed number in the 3 locules of the fruit.

Comparable determinations for other species are few in number. In *Sanguinaria* (Harris, '10) the correlations for number of ovules on the 2 placentae have been shown to be of the order $r = .89$ to $r = .92$, while the correlations for number of seeds per locule

TABLE XXII

CORRELATION BETWEEN NUMBER OF SEEDS PER LOCULE IN THE SAME FRUIT AND REGRESSION EQUATIONS SHOWING THE RELATION BETWEEN THE NUMBER OF SEEDS IN THE LOCULE OF THE FRUIT

Series	Weighted N	Correlation	Regression equation
Jefferson Barracks 1906	6720	$.7901 \pm .0044$	$l_2 = 2.1619 + .7901\, l_1$
Meramec Highlands 1906	12102	$.7119 \pm .0043$	$l_2 = 3.9669 + .7119\, l_1$
Jefferson Barracks 1907	8274	$.7408 \pm .0047$	$l_2 = 2.8374 + .7408\, l_1$
Meramec Highlands 1907	10374	$.7383 \pm .0042$	$l_2 = 3.3479 + .7383\, l_1$

have a value of $r = .80$ to $r = .84$. That the correlation for seed production is not due solely to the high correlation of the numbers of ovules on the 2 placentae is shown by the fact that the partial correlations between the numbers of seeds on the 2 placentae for constant numbers of ovules have a material value.

In *Hibiscus* (Harris, '13) it has been shown that for 1000 fruits examined at the Missouri Botanical Garden in the fall of 1905 the intra-ovarial correlations were

For ovules per locule, $r = .3843 \pm .0081$
For seeds per locule, $r = .5557 \pm .0066$

Excess for seeds $.1714 \pm .0104$

Here again the results indicate distinct physiological factors influencing the capacities of the several locules of the fruit for seed production in such a way as to bring about a similarity between them.

In *Crinum longifolium* a correlation of $r = .676 \pm .008$ has been demonstrated (Harris, '12 a) between the weight of the seeds from the same fruit.

All these results agree in indicating that there are morphogenetic or physiological factors tending to bring about a similarity in the seed production and in the seed weight of the locules of the fruit.

IV. Recapitulation and Discussion

This paper has had for its purpose the consideration of various problems of fertility in *Manfreda virginica* (*Agave virginica*). The conclusions are based on the statistical analysis of extensive series

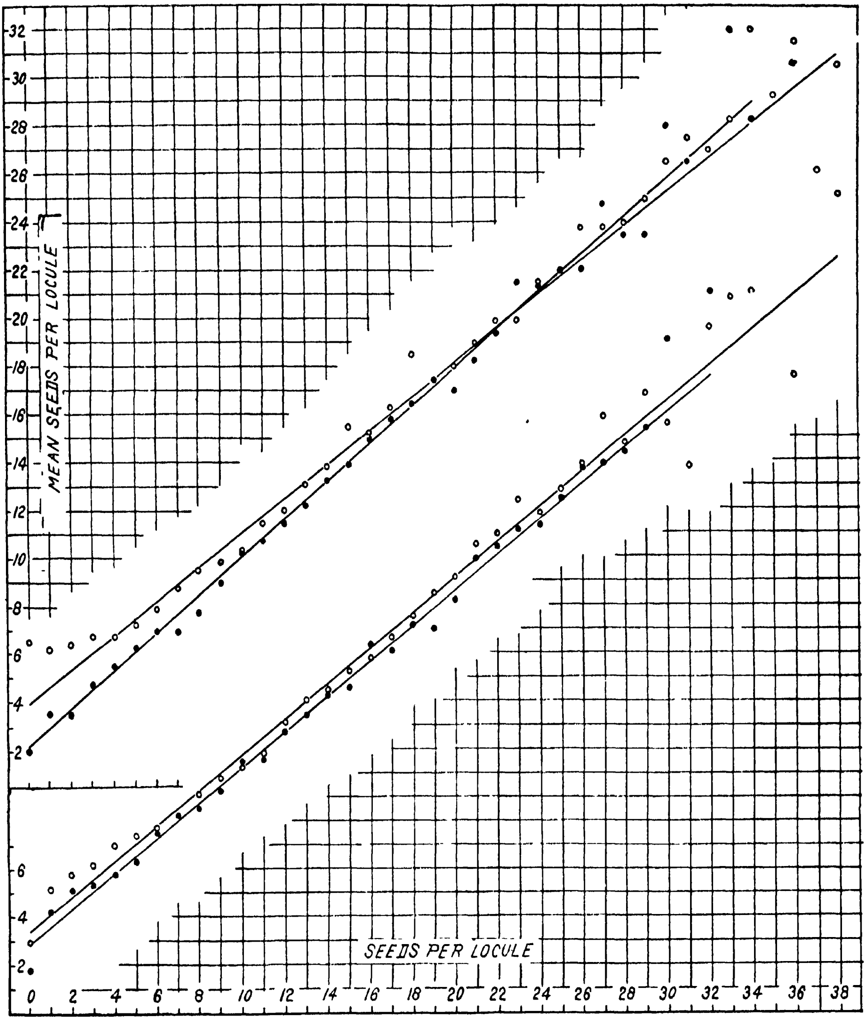

Fig. 13. Regression of number of seeds in the locule of the fruit on number of seeds in another locule of the same fruit. Circles = Meramec Highlands, solid dots = Jefferson Barracks. In both figures the upper lines (at the beginning) represent the equations for the Meramec Highlands series. Lower figure represent series for 1907, upper figure represents series for 1906.

of countings made at Meramec Highlands and Jefferson Barracks, near St. Louis, Mo., in 1906 and 1907. Briefly stated, the results are as follows:

1. The average number and the variation in number of flowers and fruits per inflorescence and seeds per locule in the two habitats and years has been determined, and compared with the available data for fertility in other species. For details reference must be made to the body of the paper.

2. About 22 per cent of the flowers develop their ovaries into fruits. The correlation between the number of flowers formed and the number of fruits matured is of about medium value. This is, however, due to the fact that as the result of chance only the larger inflorescences should produce larger numbers of fruits. A special formula shows that there is little relationship between the size of the inflorescence as measured by the number of flowers which it produces and its capacity for maturing its ovaries into fruits.

3. While the more proximal and more distal flowers on the inflorescence show a smaller proportion of fruit production, there is little relationship between the size of the inflorescence as measured by the number of flowers produced and the position of the flowers which mature their ovaries into fruits.

4. There is practically speaking no correlation between the number of flowers on the inflorescence and the number of seeds matured per locule. This is apparently in part due to the negative correlation between the number of fruits matured and number of seeds per locule. If correction for the number of fruits be made it is shown that the inflorescences which produce the larger numbers of flowers also mature slightly larger numbers of seeds per locule.

5. There is a slight negative correlation between the number of fruits ripened per inflorescence and the number of seeds matured per locule.

The physiological significance of (4) and (5) is considered.

6. The fertility of the fruits tends to decrease slightly, and approximately uniformly, from the proximal to the distal end of the inflorescence.

7. While there is little relationship between number of flowers or number of fruits per inflorescence or position on the inflorescence and the number of seeds per locule, the correlation between the number of seeds in the 3 locules of the fruit is high. Thus

there are as yet unmeasurable factors which influence in a similar manner the seed production of the 3 locules of the same ovary. These may be in part ecological, depending upon accidents of fertilization, and in part physiological.

The result of greatest importance derived from this investigation is the generally low correlation between the meristic characters of the inflorescence and fruit and seed production. While variation in seed production is clearly the resultant of underlying causes, these "causes" are not easily located in the variations of the magnitudes of any of the antecedently formed structures. Thus there is little relationship between the number of flowers formed per inflorescence and the number of seeds matured per locule. This conclusion, that there is but a low correlation between somatic characters and fertility, is in full agreement with those drawn from a consideration of the relationship between the number of parts of the involucral whorl and fertility in *Hibiscus* (Harris, '11).

This conclusion is not shaken by the more substantial correlations formed between number of pods and number of ovules and seeds in *Phaseolus* (Harris, '14), for here, as in *Sanguinaria* (Harris, '10) and in *Nothoscordum* and *Allium* (Harris, '09 b), we have questions of possible age differentiation in the perennials or of the somatic character measured standing more directly in relation to the fertility characters as means of support, conducting tracts for plastic materials, or as an actual source of the elaboration of plastic materials.

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GENERAL INDEX TO VOLUME XI

New scientific names of plants and the final members of new combinations are printed in **bold face** type; synonyms and page numbers having reference to figures and plates, in *italics;* and previously published scientific names and all other matter, in ordinary type.

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